an international monthly

THE Petroleum Engineer

Combined Edition

Drilling and Producing | Refining and Gas Processing | Oil and Gas Pipelining

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JULY 1951

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THE Petroleum Engineer

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• Drilling and Producing • Refining and Gas Processing • Oil and Gas Pipelining

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the Course of OIL

Steel Mills Need Scrap

THE steel industry confronts a serious problem—a shortage of scrap. More than one and one-half billion tons of steel are now in use in the United States. Normally, millions of tons of this steel are discarded each year and find their way back to the mill. Because of the high rate of steel production to fill military and civilian needs the steel manufacturers' scrap pile has been seriously depleted. It must be restored quickly, not only to maintain production now, but also to build up depleted inventories of scrap to carry mills through the coming winter months when seasonal scrap collections normally fall off. So serious is the scrap shortage that quick action is necessary. This is not an overnight problem, but one that will be continuous so long as the national emergency is in force.

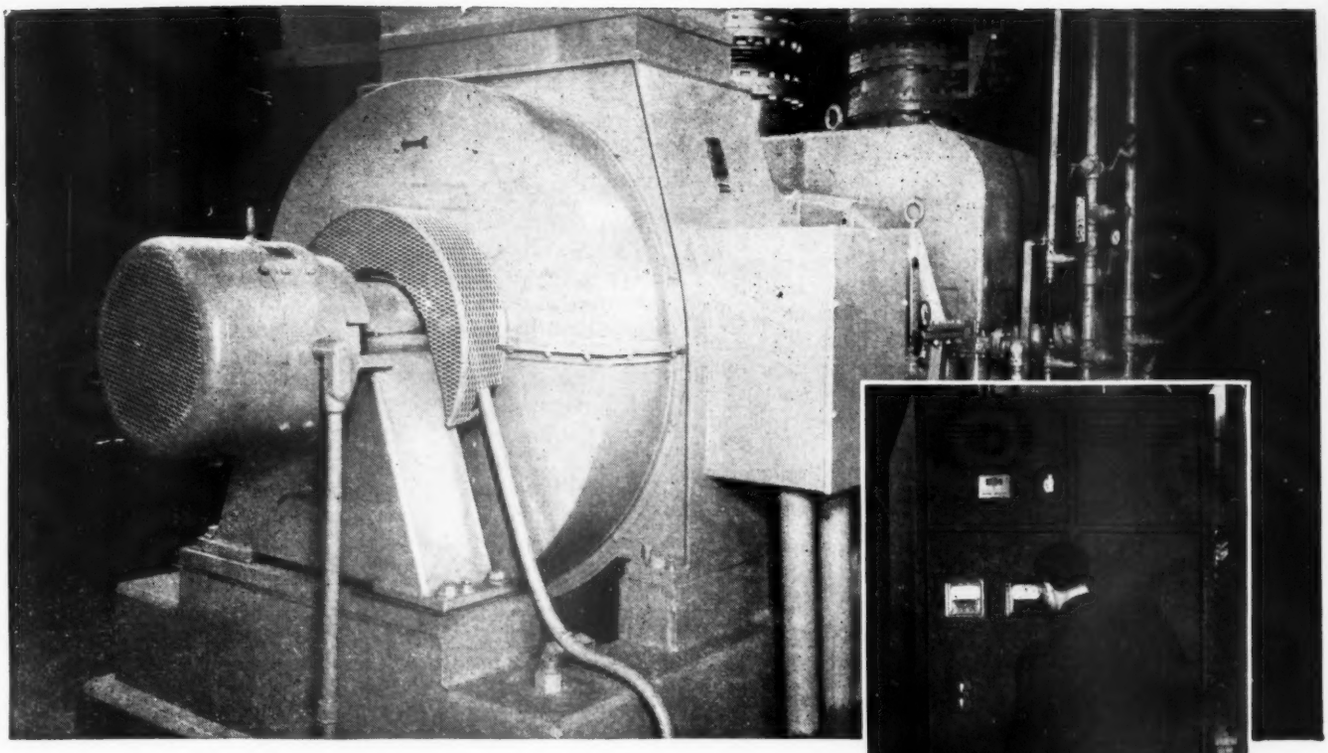
During 1950 steel production was 96,700,000 tons. In the spring of 1951 the industry was operating at an annual rate of 104,000,000 tons. By the end of 1951 the capacity should reach 107,000,000 tons, and by the close of 1952 should be 117,500,000 tons. Steel companies this year will need about 32,500,000 tons of scrap, some 3,500,000 tons more than last year's record tonnage. Next year they will need more than 35,500,000 tons. Just think, in less than three years the entire steel industry of America will have added more capacity than the entire steel capacity of Great Britain. This big increase will call for a continuous additional demand for scrap.

At a time like this when steel requirements are heavy and when steel facilities are operating at capacity, the potential seriousness of a scrap shortage is obvious. Maximum output could not be maintained. Strategically important raw material reserves could not be conserved. Already heavily taxed blast furnace facilities would be further encumbered. Steel-making costs would rise.

What about the effect of shortages on the oil industry, to which a sufficient supply of steel, particularly tubular goods, is so vitally important? A continuous scrap shortage could result in critical shortages of steel and tubular goods, the immediate outlook for which even now is not too bright.

The oil industry can help insure additional steel for its needs by a concerted and continuous effort to see that all available scrap is collected and kept flowing to the mills.

Obviously, such an effort must have the support and active interest of top management. The oil industry can do no less than give its full support toward putting into effect immediately a drive for heavy scrap.



24 HR. LIFEGUARD FOR PENICILLIN AT SQUIBB . . . . .

How Motor and Control Team Up To Keep Penicillin Growing

Gigantic fermenting tanks continuously aerated with sterile air . . . this is where penicillin is born . . . a rigidly controlled around-the-clock process at the New Brunswick, N. J. laboratories of E. R. Squibb & Sons.

The 12,000 cfm centrifugal blower pictured above helps provide the air supply which must bubble non-stop into the fermenting medium so the living penicillin cultures may breathe and grow. This is critical, for if the air supply fails, it means *sudden death* to the growing penicillin . . . a serious product loss and much wasted time, for each tank must be thoroughly cleaned and re-sterilized if a batch is spoiled.

Motor and control *must* keep the air-supplying blower running continuously during the fermenting operation. The 1500 hp, 1200 rpm, unity-power-factor E-M Synchronous Motor shown above, coordinated with an E-M Hi-Fuse Control, is specifically designed to *keep running* . . guard the life of penicillin, and save costs!

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To keep the motor running through voltage dips, time delay undervoltage protection is provided by d. c. latching. With this ingenious method, the main switch and field relays are held closed by direct current. If a voltage dip occurs. the motor keeps running and may even stay in synchronism if the dip is short.

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Another advantageous feature of this E-M Motor and Control is E-M-invented Part Winding Starting. This starts the motor in easy steps and avoids any sudden dangerous strains on the line from starting current in-rush which might knock out other plant equipment.

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Scanning WASHINGTON'S OIL HORIZON

Milburn Petty

WASHINGTON—Interior Secretary Chapman is determined to get enough steel for the oil and gas industries to supply their share of the nation's fuels requirements even if it means carrying the fight to the White House.

Chapman intends to "go higher up" if action doesn't result from his protest to the Defense Production Administration against the failure to recognize the essentiality of oil and gas as compared with other industries, which was reflected in DPA's 30 per cent slash in the third quarter steel allocation (except for production).

Rationing of petroleum products cannot be avoided in the months ahead unless DPA is willing and able to make much larger allotments of steel for oil and gas than were made in the initial determinations for the third quarter, Chapman warned in a vigorously-worded letter to Acting DPA Chief Gibson.

Tax Bill. The anti-oil bloc is likely to open up against the 27½ per cent oil-gas depletion allowances when the new tax bill gets to the Senate. Already, the so-called liberal columnists are getting in their shots, criticizing the tax bill as it came out of the House Ways and Means Committee with the depletion allowance and intangible drilling cost option unchanged. The new bill would require the withholding of 20 per cent of oil and gas royalties; also, it would apply the 3 per cent transportation tax to oil where owners of barges and tankers transport their own oil.

Line Pipe. The refining branch also will suffer from the lack of line pipe through failure to complete pipe lines needed to increase the crude supply at refineries. Right now, PAD figures there are about 485,000 bbl per day of developed crude production that has no market outlet. Included in this are about 100,000 bbl per day along the route of the unfinished Platte Pipe Line Company from the Rocky Mountain Area to Wood River, Illinois.

Cross-country oil transportation projects wanted 281,700 tons of line pipe this quarter but PAD was able to allot them only 118,000 tons or 41.9 per cent of the need.

Gas. A total of 878,300 tons of line pipe would be required to keep up construction schedules on gas transmission projects during the third quarter. Against this demand, PAD allotted 517,800 tons or 59 per cent. This means, as Chapman pointed out to DPA, that new areas—like New England—expecting to get natural gas for the coming winter will be disappointed.

Only projects to get pipe, under PAD's "get-tough" policy on gas expansion, will be those now being built to areas already dependent upon natural gas. There won't be any pipe left for other lines planned to serve new areas where other fuels are available, according to PAD.

Natural Gasoline. PAD's allotment of 50,000 tons of steel for natural gasoline plants during the third quarter represents 111 per cent of the tonnage used by this branch during the pre-Korean period. New plant construction, however, was at a low rate in the first half of 1950. The tonnage for the current quarter will not be sufficient to complete the projects now under way and support the projects that the industry is willing and ready to install. Such construction, it was pointed out to DPA, is the quickest way to augment gasoline and LP-Gas supplies.

Tubular Goods. Not included in the 963,000-ton allocation for "all other" activities were the programs for oil country tubular goods (450,000 tons) and oil field machinery and equipment (130,000 tons) for the third quarter, representing 98 and 109 per cent, respectively, of usage in the 1950 base period when operators were depleting their inventories. Of the tubular goods quota, 396,800 tons are for domestic operations; 53,200 tons for foreign.

Although this should be enough to maintain a 43,400-well drilling program during 1951, PAD warns that the oil country tubular goods situation is becoming increasingly critical because of general exhaustion of second-hand pipe, reduced inventories, less imported pipe available, and the steel mill pattern of producing large-size casing in quantities out of balance with the industry's needs for small diameter casing due to deeper drilling.

Coal Hydrogenation. While Chapman is going to bat for materials needed by the oil and gas industries, it can be expected that he will also make a strenuous effort to get steel for synthetic fuels, a project that is close to his heart.

Interior Department is now considering a tentative proposal for a coal hydrogenation project to be privately financed by a group of banks and insurance companies. It would cost $220 or $380,000,000, depending on whether a 15,000 bbl per day or 30,000 bbl per day plant was built. Output woud be 60 per cent chemicals (mostly aromatics) and 40 per cent other light products including aviation gasoline, motor gasoline, and LP-Gas.

The proposal hinges on the government entering into 10-year purchase contracts for the plant's output, based on ceiling prices prevailing in the early part of 1951. Ferdinand Eberstadt, a WPB sparkplug during World War II, submitted the proposal on behalf of an eastern syndicate.

Tankers. Office of Price Stabilization, in conjunction with other agencies, is making a study of domestic tanker rates to determine whether or not they should be rolled back. Meanwhile, as a measure of relief for East Coast marketers, OPS has granted increases in the ceiling prices of residual fuel oil ranging from 17 to 31 cents per barrel along the Atlantic Seaboard.

Oil Compact. An extension of congressional authority for the Interstate Oil Compact seems assured now that the Department of Justice has given the Compact a clean bill of health under the antitrust laws. When questioned about charges in a 1949 report by Senator Wherry's Small Business Committee, Assistant Attorney General Morison told the House Commerce Committee: "So far as we are concerned, no facts have been given us that would justify our objecting to continued operation of the Compact."

TEL. Prodded by the battery manufacturers and other large users of lead, the National Production Authority is considering a pig lead allocation system that might reduce the amount available for tetraethyl lead for motor fuel. To meet the argument that gasoline octane ratings are still higher than necessary, PAD is gathering data to show that, relatively speaking, today's octane ratings—in comparison with the requirements of present-day cars—are no higher than the gasolines were 10 to 15 years ago. If the pig lead supply for TEL were cut, it would probably mean that PAD would have to set octane ceilings as well as restrict the use of lead in motor gas fuel.

more horse-power per pound

Famous for stamina and a sure foot, the burro was a hard-working "pardner" of the old-time prospector. He's a little fellow—but he packs more horse-power per pound than any of his four-footed cousins . . .

This ability to get more work done with fewer pounds to do it is precisely what Aldrich Direct Flow Pumps have to offer. As a result of improved design, weight of the fluid-end is considerably reduced. And—whereas a speed of 150 rpm was formerly considered high for reciprocating pumps—these compact, Direct Flow units are operating today at speeds of 500 rpm for the 3″; 360 rpm for the 5″; and 300 rpm for the 6″ stroke. In each case, you get greater volume and higher pressure from a smaller pump: *you get more horse-power per pound.*

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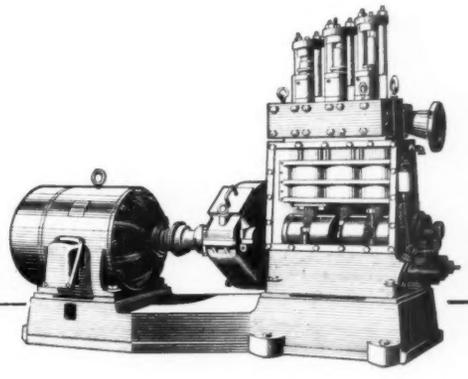

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HIGHLIGHTS IN OILDOM

TRANSPORTATION AFFECTS OIL OUTPUT

Without completion of the Platte River pipe line, oil production in the Rocky Mountain region cannot reach capacity limits. Henry S. Phillips, vice president and production chief of Sinclair Oil and Gas Company, has declared. Construction of the 20-in. line from Worland, Wyoming, to St. Louis, Missouri, is stymied by lack of steel allocation to complete a 500-mile stretch in Kansas and Nebraska.

U. S. COMPANIES PROVIDE TOOLS

Commenting on the Middle East oil situation, Eugene Holman, president Jersey Standard, said: "Jersey affiliates, like other companies, producing oil in other lands, have long recognized that the oil underground belongs to the people of these lands." He added that the U. S. provides tools for reclaiming the oil, and marketing outlets necessary, without which the oil would be of no use to anyone.

REFUSE TO ATTEND OIL PRICE MEET

A request to major oil industries to meet in the governor's mansion in Lansing, Michigan, to discuss absorbing the newly enacted 1½-cent gasoline tax increase in that state, has met with polite, but definite, "No's." Sun Oil president, Robert G. Dunlop, and A. W. Peak, Standard Indiana president, both reminded Governor G. Mennen Williams that such a meeting would break both state and federal antitrust laws.

GASOLINE TAXES RISE

The federal government collected $174,520,729 in gasoline taxes during the four months of 1951, establishing a record high. This was an increase of 7.1 per cent over the like period of 1950, according to the Bureau of Internal Revenue. Receipts from the federal lubricating oil tax totaled $27,989,924 in the first 4 months, a rise of 28.2 per cent from the 1950 period.

U. S. STEEL OUTPUT HITS PEAK

United States Steel is celebrating its 50th anniversary this year, by shattering all previous records of production, according to the company's anniversary edition of The U. S. Steel Quarterly. April hit a peak with 104.1 per cent of rated capacity production. Several district plants contributed to the overall figure by bettering their own records, some of them set in World War II.

SULFUR CONSUMPTION CURBED

The NPA has ordered that sulfur consumption be held to 100 per cent of last year's rate. One word of good news for the sulfur users is that they will not be compelled to obtain NPA authorization to purchase sulfur, but will be required to make monthly reports on end uses and inventories. About 75 per cent of the sulfur produced goes for making sulfuric acid, which is needed by the oil industry as an alkylation catalyst and in cracking catalyst manufacturing.

SHALE PLANT URGED

In its report to the government on the U. S. need for synthetic fuels, DPA stated that only 3.7 tons of steel per daily barrel of product would be required for oil shale as compared with 4.7 tons for petroleum. The DPA report urged immediate beginning on a commercial size plant so that oil shale as a possible contributor to our liquid fuels can be determined.

GASOLINE IMPROVED SINCE 1925

During the last 25 years the oil industry has increased the performance of gasoline by 67 per cent, and at the same time cut the cost substantially, members of the third World Petroleum Congress were told. Standard Oil Development president, E. V. Murphree, stated that one gallon produced in 1950 was 67 per cent more powerful than a gallon of motor fuel made in 1925, based on knock-free performance. In the same period, the bulk cost at the refinery dropped in the U. S. to 10.5 cents a gallon in 1950 from 12 cents in 1925.

SUMATRA IS FUTURE OIL SOURCE

Sumatra is the future major source of gasoline and kerosine supply for Asia and the South Pacific, R. G. Follis, board chairman, Standard of California, reported. Recently returned from a tour of the Middle and Far East, Follis remarked that Caltex markets throughout the Eastern Hemisphere have given further importance to Indonesian oil, particularly as a supplemental source of supply for Far East, Australia, and New Zealand.

OIL FIRM SYSTEM PRAISED

In contrast to most publicity given the oil industry, an article in the June issue of Harper's magazine states that the system of governance of Standard Jersey is a striking example of cooperative effort at the highest level.

OPS WANTS LICENSING RIGHT

The Office of Price Stabilization has presented its request for licensing authority in a memorandum to the House and Senate Banking Currency Committees. The licensing system, contained in a pending amendment to legislation extending the Defense Production Act of 1950, would be used to "restrain the persistent violator" of government directives. There is little chance of Congressional approval. The news is that such a scheme of federal control over all business should be offered.

LEASING LAW REVISED

A bill permitting issuance of leases in Arizona for as long as oil and gas is produced in paying quantities has been passed. The Arizona Statehood Enabling Act formerly had 20-year limitation on oil and gas leases, and sponsors of the recent legislation contended that this limitation tended to retard oil and gas development in the state.

IOC ESSENTIAL, SHIVERS CLAIMS

Failure to ratify the Interstate Oil Compact would result in "organized confusion," Texas Governor Shivers reported to the House recently. In support of legislation to extend the IOC for 4 years from September 1, Shivers pointed out the IOC has contributed greatly to the ability of the oil industry to meet defense needs, and that recovery of oil from fields once thought exhausted has resulted in saving billion of barrels of oil. The Senate has already approved a 4-year extension of the IOC.

ATTACKS U. S. FOREIGN AID

Relations between the U. S. and European countries are becoming demoralized by governmental monetary grants, George A. Sloan stated in a speech before the International Chamber of Commerce. Chairman of the U. S. Council, Sloan declared that the major activities for foreign economic development must come from private sources.

GOODWILL IN THE OIL INDUSTRY

J. F. Brantley, Drilling and Exploration, reported to the third World Petroleum Congress that ideas must be exchanged if the petroleum industry is to progress. The congress affords this opportunity, he declared, along with building up goodwill that will be reflected in the years to come.

For EXTRA LIFT CAPACITIES

on crawlers or rubber, check **KOEHRING CRANES**

Whether your oil field operating conditions demand sure-footed crawler traction to lick toughest mud and grades . . . or require speed and mobility of rubber tires to cut travel time between widely-scattered jobs . . . it will pay you to check the extra lift capacities of Koehring crawler-mounted and rubber-tired cranes.

In lift crane service, the heavy-duty 304 (above) safely handles up to 25 tons . . . Koehring 205 (right) lifts up to 10 tons, depending on type of mounting. Both the ¾-yard 304 and ½-yard 205 are readily convertible from lift crane to clamshell, dragline, hoe or shovel on crawlers or rubber tires. Two larger Koehring sizes on crawlers provide 1½ and 2½ yard dipper capacities . . . 36 and 79½-ton lift capacities.

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XUM

National Petroleum Situation

By H. J. STRUTH*

DRILLING MAY LAG. Despite assurances of adequate steel supplies, many operators are feeling the pinch, and many new well starts are being delayed. Unless there is some easement in the steel situation, it is likely that drilling operations this year will fall below the rate experienced last year. Reports indicate a lag between new drilling locations and actual starts, which is reflected currently in the development drilling statistics. Wildcat operations are holding well ahead of last year, with a cumulative increase of 23 per cent. Lack of steel may also retard wildcat drilling over the balance of this year.

DEMAND UP 15 PER CENT. Demand for all oils in the first 5 months of this year was 15 per cent above the same period of 1950. Motor fuel demand is 14 per cent greater, and fuel oil demand is 13 per cent above last year. Demand for domestic crude oil is 19 per cent greater than last year. Domestic crude requirements averaged 6,030,000 bbl daily in the first 5 months of 1951, against a daily average last year of 5,080,000 bbl daily. National crude production this year to date has averaged 6,043,000 bbl daily, against 4,976,000 bbl daily in 1950. Production is 21 per cent above last year.

IMPROVED STOCK POSITION. Stocks of all oils apparently increased about 10,000,000 bbl in May, effecting a material improvement in the national stock position. Crude stocks increased 4,000,000 bbl, while stocks of fuel oils rose more than 12,000,000 bbl during May. The seasonal increase in motor fuel demand, which began in May, reduced stocks of that product by nearly 7,000,000 bbl. In relationship to demand, motor fuel stocks are lower than a year ago. Stocks on May 31 represented 39 days' supply, against 41 days' supply last year.

IMPORTS UP 11 PER CENT. Imports of crude and products in the first 5 months of this year were about 11 per cent above the same period of last year. Imports this year have averaged about 905,000 bbl daily, against a daily average in the first 5 months of last year of 811,000 bbl. Crude oil imports are about 7 per cent greater than last year, while imports of refined products have shown an increase of about 19 per cent. World markets for U. S. crude and products are expected to show further expansion particularly in the light of political strife in the Middle East.

*Petroleum Consultant, Dallas, Texas

Comparative Statistics, May, 1951

*All figures are computed on a Bureau of Mines' Basis**

	May 1951 (P)	April 1951 (R)	May 1950	This Year to date (P)	Last Year to date	Per cent change
Total supply,* all oils	235,890	227,929	197,440	1,134,684	945,514	+20
Daily average	7,609	7,598	6,369	7,514	6,262	
Total demand,‡ all oils	225,770	228,989	197,844	1,151,114	1,000,328	+15
Daily average	7,283	7,633	6,382	7,623	6,625	
Change in stocks	+10,120	—1,060	—404	—16,430	—54,814	
Crude supply*	207,970	199,110	173,059	987,394	821,538	+20
Daily average	6,709	6,637	5,583	6,539	5,441	
Crude demand‡	203,920	191,134	177,787	990,007	835,017	+19
Daily average	6,578	6,637	5,735	6,556	5,530	
Crude stocks	245,850	241,800	239,877	245,850	239,877	+ 2
Days supply	37	36	42	37	42	
Natural gasoline production	18,200	16,400	14,229	85,301	71,470	+19
Daily average	587	547	459	565	473	
Motor fuel production	95,800	88,650	84,801	455,712	398,817	+14
Daily average	3,090	2,955	2,736	3,018	2,641	
Gasoline yield per cent	41.5	41.2	44.0	40.9	43.3	— 2.4
Motor fuel demand‡	102,860	93,428	91,260	442,149	388,161	+14
Daily average	3,318	3,114	2,944	2,928	2,571	
Motor fuel stocks	129,750	136,800	121,078	129,750	121,078	+ 7
Days supply	39	44	41	39	41	
Fuel oil production	76,800	75,030	64,502	399,809	324,050	+23
Daily average	2,477	2,501	2,081	2,648	2,146	
Fuel oil demand‡	74,690	87,449	69,222	481,689	426,342	+13
Daily average	2,409	2,915	2,233	3,190	2,823	
Fuel oil stocks	92,260	80,550	82,221	92,260	82,221	+12
Days supply	38	28	37	38	37	
Refinery still runs	201,750	189,200	171,599	975,188	811,638	+20
Daily average	6,508	6,307	5,535	6,458	5,375	
Stocks, all oil	566,280	556,160	548,305	566,280	548,305	+ 3
Days supply	78	73	86	78	86	

Current Crude Oil Prices

U. S. average	$2.58	Louisiana	$2.62	**Basic crude prices:**	
Texas	2.61	Arkansas	2.43	Oklahoma-Kansas (36 gr.)	$2.57
California	2.42	New Mexico	2.40	Texas Gulf Coast (36 gr.)	2.80
Oklahoma	2.62	Mississippi	2.23	East Texas	2.65
Kansas	2.62	Illinois	2.76	West Texas (36 gr.)	2.44
		Other states	2.60	California Signal Hill (26 gr.)	2.31
				Pennsylvania, Bradford	4.25

Drilling and Production Statistics

	May 1951 (P)	April 1951 (R)	May 1950	This Year to date (P)	Last Year to date	Per cent change
Wells drilling	5,290	5,145	4,720	5,290	4,720	+12
Total wells drilled	3,734	3,319	3,606	16,468	16,073	+ 2
Development wells	2,712	2,477	2,918	12,490	12,839	— 3
Oil	1,744	1,676	1,946	8,340	8,868	— 6
Gas	229	139	250	959	978	— 2
Dry	739	662	722	3,191	2,993	+ 7
Per cent dry	27.2	26.7	24.7	25.5	23.3	+ 2.2
Service wells	55	48	42	252	321	—22
Wildcat wells	967	794	646	3,726	2,913	+28
Oil	163	123	106	621	442	+40
Gas	32	18	14	116	82	+41
Dry	772	653	526	2,989	2,389	+25
Per cent dry	79.8	82.2	81.4	80.2	82.0	— 1.8

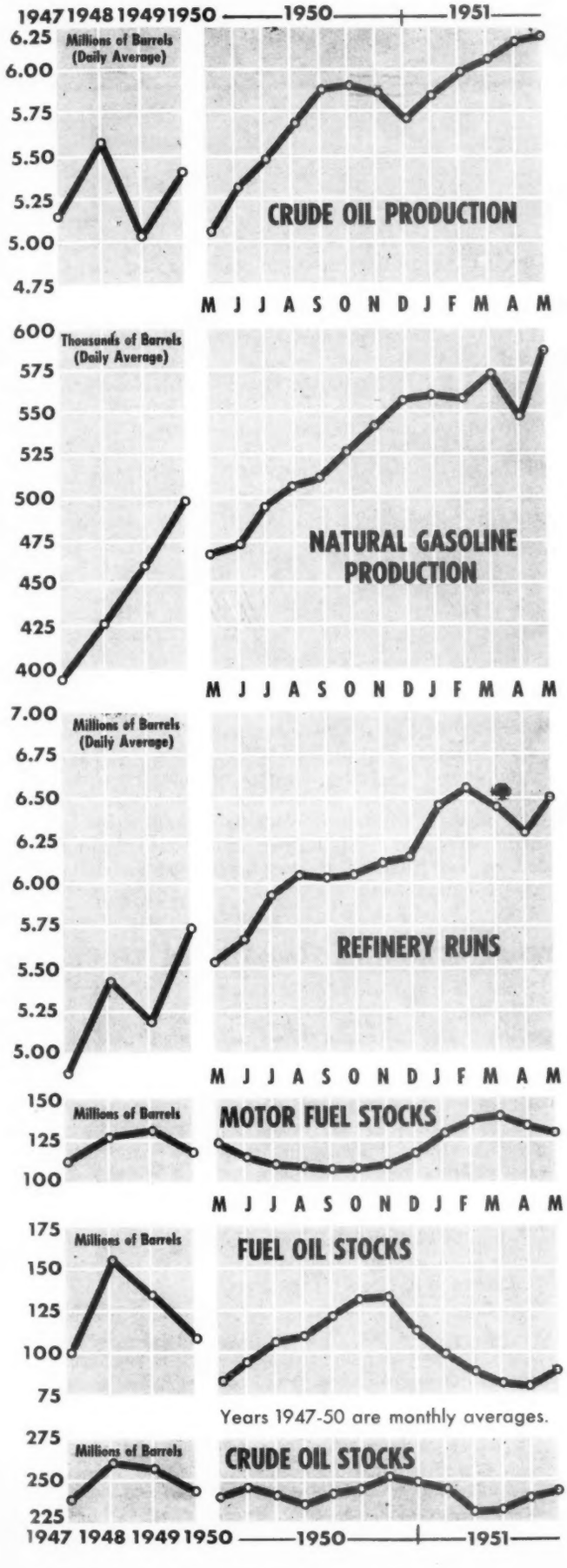
By State

Wells drilled (excl. service)	3,679	3,271	3,564	16,216	15,752	+ 3
Arkansas	23	37	34	154	155	— 1
California	204	177	143	833	689	+21
Illinois	195	114	262	697	925	—25
Kansas	416	355	326	1,752	1,417	+24
Louisiana	158	157	214	807	985	—18
Mississippi	34	23	29	111	138	—20
New Mexico	57	52	49	256	269	— 5
Oklahoma	532	478	461	2,282	2,069	+10
Texas	1,440	1,341	1,381	6,682	6,490	+ 3
Other states	620	537	665	2,642	2,615	+ 1
Wildcats drilled	967	794	646	3,726	2,913	+28
Arkansas	8	12	9	38	40	— 5
California	39	41	38	187	156	+20
Illinois	70	25	57	171	235	—27
Kansas	113	96	75	428	264	+62
Louisiana	22	22	19	126	111	+14
Mississippi	14	10	12	50	59	—15
New Mexico	10	7	8	44	34	+29
Oklahoma	91	95	76	411	345	+19
Texas	428	347	253	1,684	1,269	+33
Other states	172	139	99	587	400	+47
Daily crude production	6,184	6,150	5,143	6,043	4,976	+21
Arkansas	82	82	86	75	85	—12
California	961	962	872	961	863	+11
Illinois	162	154	171	159	170	— 6
Kansas	311	328	292	313	283	+11
Louisiana	635	632	539	630	543	+16
Mississippi	100	101	103	102	100	+ 2
New Mexico	141	145	130	140	128	+ 9
Oklahoma	500	500	427	500	410	+22
Texas	2,821	2,786	2,113	2,698	1,988	+36
Wyoming	186	190	155	189	157	+20
Other states	285	270	255	286	249	+15

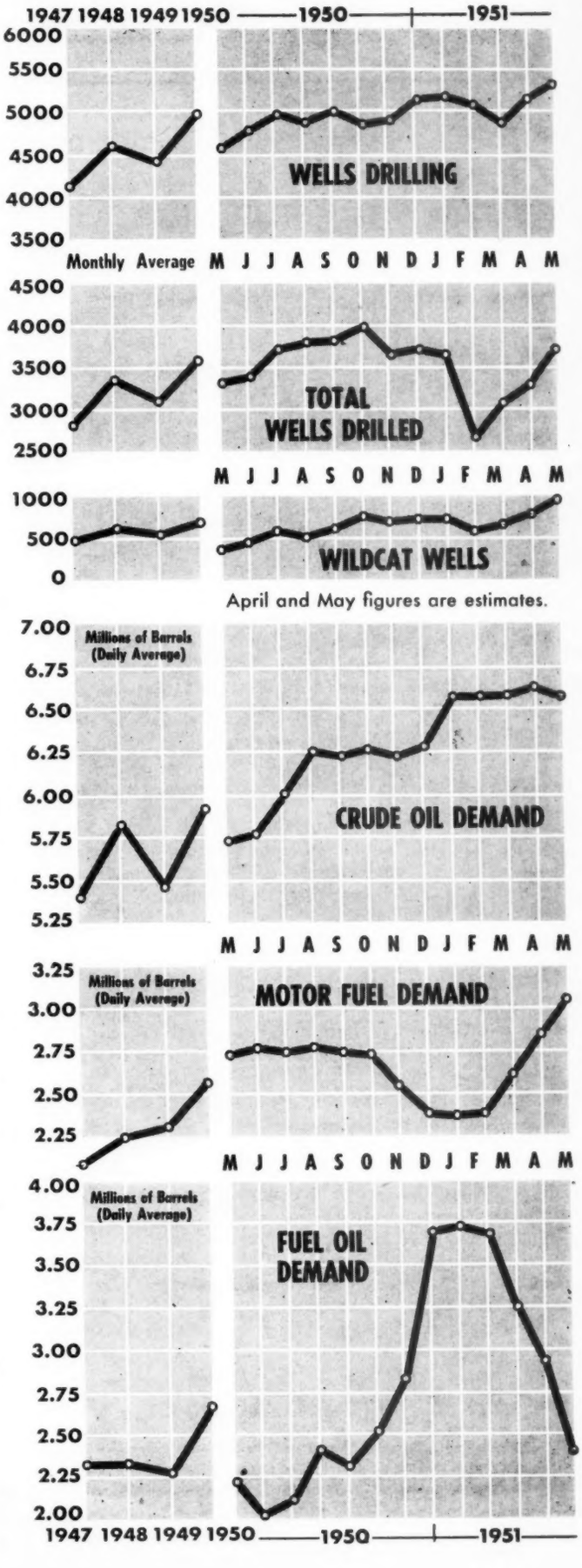
* Unless otherwise stated all figures represent thousands of barrels. ‡ Total demand, including exports. * Includes domestic production and imports. (P) Preliminary. (R) Revised.

Preliminary estimates based upon data supplied by American Petroleum Institute, U. S. Bureau of Mines, State Agencies, and other official sources.

National Petroleum Situation


1947 1948 1949 1950 —— 1950 —— 1951
Millions of Barrels (Daily Average)
CRUDE OIL PRODUCTION
M J J A S O N D J F M A M
Thousands of Barrels (Daily Average)
NATURAL GASOLINE PRODUCTION
Millions of Barrels (Daily Average)
REFINERY RUNS
Millions of Barrels
MOTOR FUEL STOCKS
Millions of Barrels
FUEL OIL STOCKS
Millions of Barrels
CRUDE OIL STOCKS
1947 1948 1949 1950 —— 1950 —— 1951

Years 1947-50 are monthly averages.


1947 1948 1949 1950 —— 1950 —— 1951
WELLS DRILLING
Monthly Average
M J J A S O N D J F M A M
TOTAL WELLS DRILLED
WILDCAT WELLS
Millions of Barrels (Daily Average)
CRUDE OIL DEMAND
MOTOR FUEL DEMAND
FUEL OIL DEMAND
1947 1948 1949 1950 —— 1950 —— 1951

April and May figures are estimates.

XUM

PETROLIC PERSONALITIES

DICK SNEDDON

EATS ARE EXCELLENT IN TULSA

Without any kind of formality other than the mere opening of its doors, the Petroleum Club of Tulsa began operations last March 5 and has been going great guns ever since. The roster consists of some 550 regular members, 76 nonresident members, and we are told that there is a waiting list of about 150. There is no question that this congenial hostelry fills a long wanted need.

According to our Oklahoma operative, the members have been so impressed by the high quality of the food and the low cost that they linger over the dining tables until it is time to go back to work. They haven't even taken the wrappings off the domino boxes—after three months, fancy that! Why, in the Petroleum Club of Los Angeles, if the waiter doesn't bring the dominoes before he serves the soup, the diners all have violent indigestion. That has nothing to do with the case in point, however, and we rather imagine that before long the atmosphere of the Tulsa Petroleum Club will also resound to the click of the spotted tiles. It has certainly become the most popular game among western oil men and as it is reputed to have originated with the Mid Continent people it will undoubtedly be taken up by the Tulsans in good time.

MAY BE RELATED TO SLAMMIN' SAMMY

President of the Tulsa Petroleum Club is Earl Sneed of the oil company by the same name, and by all accounts a personality of consequence. We haven't found out yet whether or not he is any relation to Slammin' Sammy, the golf biggie, but in any case he needs no reflected glory and is quite capable of doing his own scintillating. Vice president is John Campbell, superintendent of gas and gasoline for Carter Oil Company and another man of great moment. We suspect that somewhere in John's ancestry there is a sprig of heather and if that is confirmed we may have a later story. Secretary is Frank Taylor, editor of Independent Monthly, who should fit in to the administrative matrix of the Club as pleasingly as the last piece of a jig-saw puzzle.

Chancellor of the Exchequer is Bob Wood of the Bros. Wood Oil Company, a firm that in its very inception showed profound disregard for convention by its display of originality. When the Wood brothers organized, instead of adopting the time-worn system and calling themselves Wood Bros., they reversed the words and became Bros. Wood. The board of directors of the Tulsa Petroleum Club consists of 14 oil men and one equipment representative, and its membership is an excellent cross-section of the Mid-Continent oil business, including such industrial greats as Bill Skelly and John Mabee.

THE McKEESPORT METALLURGIST

Incidentally, we have it on reliable authority that the one equipment man on the 15-man board is our old friend Herbert Mains Cooley, a McKeesport, Pennsylvania, boy who has made more than good in the oil business for Bethlehem Steel Company. We first met Herb in the Sky Room of the Hilton Hotel at Long Beach, California, one dark night some years ago when with By Landis, the Web Wilson Tool Company yellow tiger, we were doing the highland fling for a select group of terpsichoreans after closing hours.

There were sundry drilling contractors in the group and as nearly as we can remember Herb was hosting them in his usual capable manner. Be that as it may, we have since come to know him better and have had no trouble in deciding that he is pretty swell people. He is a graduate of Carnegie Tech in metallurgical engineering with a lot of post graduate work in alloy steels and is on the staff of the Bethlehem operating vice president. His particular interest is the metallurgy of drill pipe, casing, tubing, sucker rods, wire rope, and other oil field essentials. He began his career with National Tube Company in 1923 and in 1935 was transferred to Tulsa as field engineer. Three years later he moved over to Bethlehem Steel and soon was adopted by the metallurgical department. He is now assistant metallurgical engineer.

In his spare moments Herb is an enthusiastic color photographer and once in a moment of weakness he even confessed that he finds his best subjects in California. He has photographed Forest Lawn, Sequoia, Yosemite, San Francisco (from the Top of the Mark), and indeed has one of the oil industry's finest libraries of color transparencies. There are times when Herb wishes he didn't give quite so much of his spare time to color photography, for instance when he gets into a domino game with Frank Smith, Ralph Clemons, and Elmer Wycoff, and gets taken for slightly less than the national debt.

YOUR SCRIBE IS TOASTED IN CHICAGO

Some time ago we wrote a note to Cy Perkins, the well known Chicago barber shopper, suggesting that he keep a weather eye open around the Loop for one Herb Graffis, a grand guy with whom we have had sporadic dealings in the past. Herb used to be the publisher of a couple of golf magazines to which we made occasional contributions and was —maybe still is—sports editor of Esquire among other things. Anyway, it just happened that a few nights later, Perky and his quartet were singing at a Western Electric Company banquet and who should be the speaker of the evening but the said Herb Graffis. He did himself proud according to Perk indulging his oratorical propinquities in a home spun, regular guy type of delivery that reminded him a bit of Will Rogers.

The important thing as far as we are concerned, however, was that the heel of the evening was punctuated with frequent sallies to the dispensary to toast the health of your scribe to the several signs of the zodiac. A fine excuse, we would say, for doing something they were going to do anyway. The exchange of correspondence occasioned by this chance meeting, however, produced some quite unexpected results as it stimulated our Chicago operative to some flattering exhortation on the subject of an interesting individual, to-wit, Art Zoll, described in the report as "a songster, *bon vivant*, and all-around good fellow."

Now--A Completely Hydraulic Dragshovel

The New BUCYRUS-ERIE HYDROHOE

- ★ Two separate digging actions
- ★ Eliminates up to 40 percent time lost moving up
- ★ No bails, sheave blocks or drag ropes to interfere with loading
- ★ Digs a level trench — reduces hand trimming, no scallops
- ★ Precision control — every work function fully hydraulic
- ★ Hydraulic ejector assures fast, clean dumping of dipper
- ★ Travels up to 50 mph. on open highway

Here is a completely new idea in dragshovels for trenching and related digging — the Bucyrus-Erie Hydrohoe. Every operating function is fully hydraulic — boom hoist, swing, dipper dig and dump, boom telescope, outrigger set and retract, and positive dirt ejector.

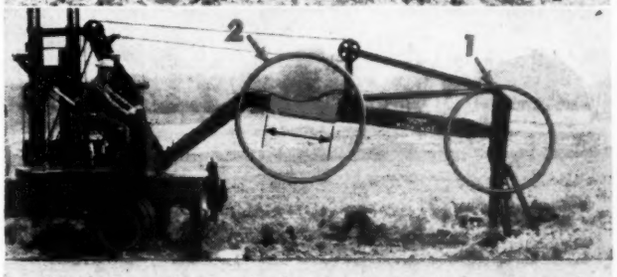
Control is so precise, Hydrohoe can operate efficiently and safely around buried pipe and conduit. Dipper can be moved a fraction of an inch if necessary.

Write today for full details. We'll be happy to arrange a demonstration.

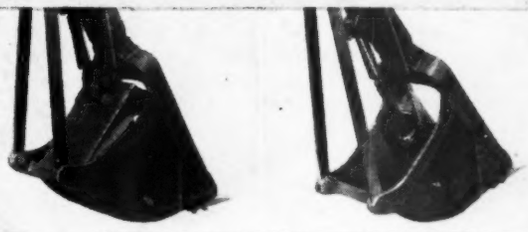
BUCYRUS-ERIE HYDROCRANE DIVISION
SOUTH MILWAUKEE, WISCONSIN

★ Quickly convertible to crane in the field for handling buckets, forks, magnet and crane hooks.

HYDROHOE—A NEW MONEY-MAKING FRONT-END FOR THE VERSATILE HYDROCRANE



The Hydrohoe is the only dragshovel with two separate and distinct digging actions. The first is through a hydraulic ram located between boom and dipper handle. The second digging action comes from telescoping the boom. This exclusive telescope feature eliminates moving dragshovel back and forth when digging out boulders and excavating across pipe and cable . . . permits digging a level, scallop-free trench, greatly reducing hand trimming.



Available with interchangeable 18-in. and 12-in. wide self-discharging dippers, the Hydrohoe is adaptable to a wide variety of digging and trenching jobs.

XUM

THE POLYSYLLABICS OF REFINING

It seems that Art has for many years been profitably and pleasantly employed as a salesman of refinery equipment as well as an operator but now has decided to trade the wide open spaces for four square feet on the business side of a desk. He has recently been adopted into the purchasing department of Procon, Incorporated, an organization of veteran refinery operators who have banded themselves together for the purpose of engaging in refinery construction. Art is a native of the considerable city of Alton, Illinois, and is an alumnus of Shurtleff College at Alton, and Washington and Lee in Virginia, where he led the vigorous life, going in for football, track, and other unmentionable but equally strenuous pursuits.

Since leaving school, he has had a raft of experience in the polysyllabic processes by which the stubborn hydrocarbons are broken down and reformed into more agreeable entities. Of catalysis, polymerization, isomerization, dehydrogenation, and similar ponderosities he has no fear whatever and he is as thoroughly acquainted with the complex mechanisms of the refinery as is the country doctor with the anatomy of his prize patient.

MAKES A QUARTET OUT OF A FOURSOME

Art began his career with the old Roxana Company in Wood River, was subsequently in charge of cracking operations at Shell's East Chicago plant in Indiana, and later still was superintendent of the White Star Refinery at Trenton, Michigan. This plant was eventually purchased by Socony Vacuum Company. In the roaring thirties he allied himself with National Tube Company for a spell; then became midwestern representative for Ralph M. Parsons; and now has given up selling entirely to devote himself to buying. Art is widely known and highly regarded by refiners in all parts of the country and his acquaintance in the industry along with his intimate knowledge of equipment and process should be invaluable in his new adventure.

He makes his home in Evanston, Illinois, and his number one hobby is singing. Besides a keen sense of humor he has an excellent tenor voice with which he shatters the welkin on the slightest provocation. Although on occasion he hies out to the links and launches a vicious attack on the unresisting sod with his niblick, it is popularly believed that the real purpose of these forays is to form a quartet in which he can disport at the 19th hole.

On the Oil Front

"YOU MAY KNOW YOUR STUFF AT THE REFINERY, PAW, -BUT I WISH YOU'LD LEAVE THIS TO SOME ONE ELSE!"

ANNUAL DONNYBROOK IS BIG HIT

Foregathered with the California Natural Gasoline Association members at the Rio Hondo Country Club a Saturday or two ago and had an elegant time lolling on a deck chair while ambitious young bloods wore themselves to a frazzle in such exhausting exercises as horse shoes, baseball, darts, golf, African dominoes, spit in the sink, elbow crooking, and just plain slapping long lost friends on the back and screaming astonished recognition. The frolic was blessed with splendiferous weather and being manned by an exceptional roster of frolic-manners was a real success from beginning to end, for which the general committee is to be complimented.

Helping to shape the affair and put it on in excellent style were such budding Billy Roses as Charlie Rajnus, Ingersoll-Rand; Myron Niesley, California Testing Labs; Fred Carter, Fisher Governor; Harold Dresser, Marley Company; Verne Frost, Materials Service; Gordon Greene, Gordon Greene Company; Les Gfeller, General Electric Company; Dick Jenkins, Clark Bros.; Roland Raasch, Oilfield Construction Company; Bob Sutherland, Worthington Pump; and Bob Williamson, Cooper-Bessemer. These impresarios laid themselves out no end to assure the total success of the annual donnybrook.

BATS AND CHEWING TOBACCO IDENTIFY BASEBALL GAME

Much to the surprise of everyone, including the Oilers, the Oilers won over the Hotshot Peddlers in a game that was undoubtedly supposed to be baseball. You could tell it was supposed to be baseball by the bats and the chewing tobacco, otherwise it had no resemblance to the national pastime. Dick Jenkins was in charge of this event but in all fairness should not be held responsible. Bob Sutherland, heaven help him, was in charge of the horseshoe contest, which was one of the most popular games of the day. Some of the boys pitched the shoes as if the horses were still attached but there were others who occasionally hit the pitch. Golf, of course, always gets top billing at the CNGA frolic and the tournament was well patronized. In this connection it is fortunate that the frolic is only held once a year because that gives Bill Bryant and the Rio Hondo people a chance to get the fairways back in place between attacks.

Winners this year were E. R. "Mike" Henry, Southern Counties Gas Co., members' low gross; Marion Ford, Pacific Gas and Lighting Supply, members' low net; H. T. Stensrud, Southern California Gas Company, guests' low gross; George Murdock, Cooper-Bessemer, M. D. Pearson, and Art Burns, Manning Maxwell & Moore, all tied for guests' low net. Bob Williams of C.C.M.O. came nearest to making a hole-in-one and a prize for the largest and most interesting divot was unanimously awarded to Tom Taggart whose exhibit was about the size and shape of Catalina Island. George McLaren, the amiable prexy-to-be, from Standard of Cal, was there in person shedding the sunshine of his ready smile all about as usual, and Ed Millett, Jr., did his customary top job of correlating all the activities. We would especially commend the vaudeville show that was staged after dinner by Walter Trask. It was one of the best we have seen in a long time.

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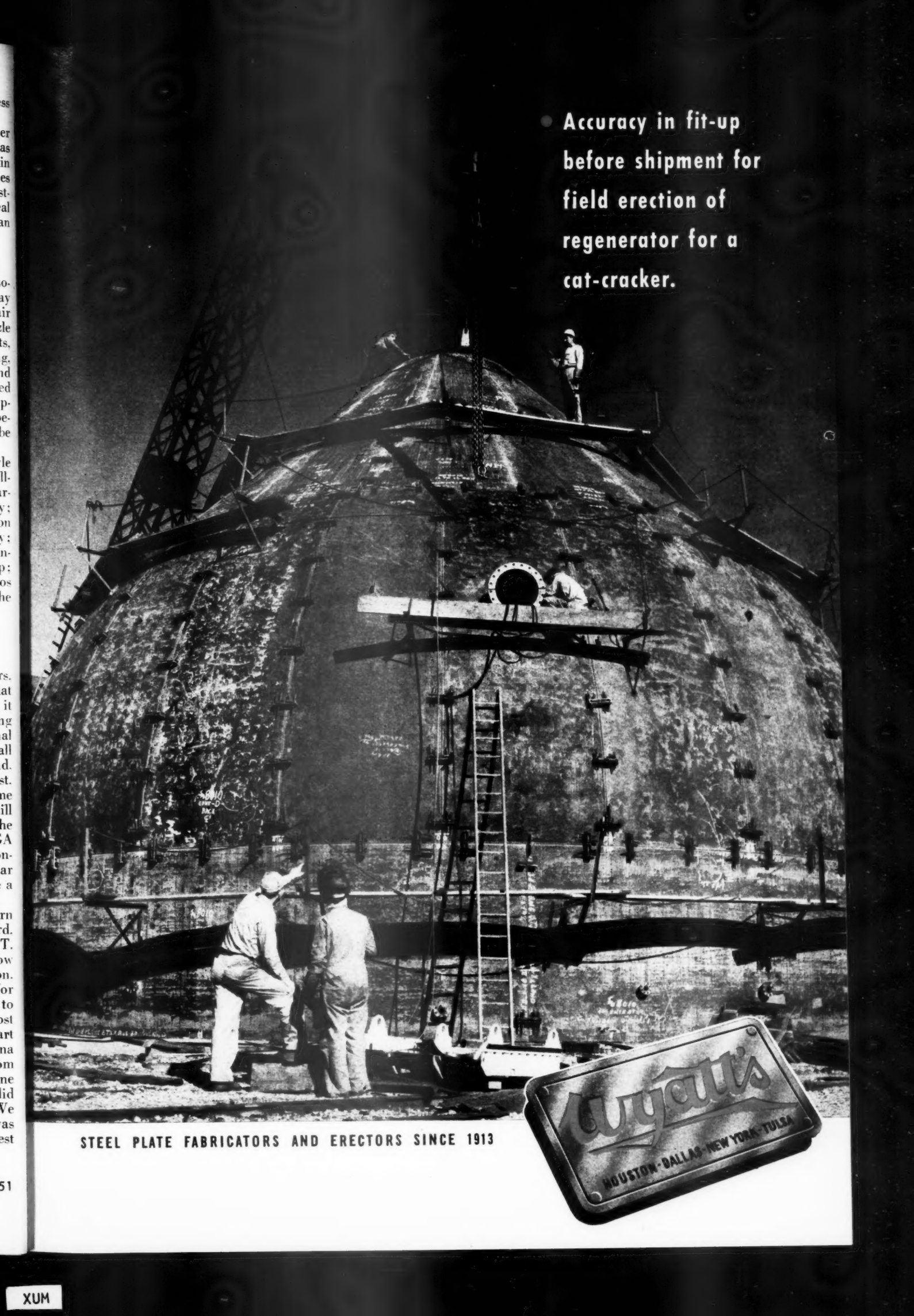
Accuracy in fit-up before shipment for field erection of regenerator for a cat-cracker.
Wyatt's
HOUSTON-DALLAS-NEW YORK-TULSA

STEEL PLATE FABRICATORS AND ERECTORS SINCE 1913

UNITED STATES ANNUAL CRUDE OIL RESERVES AND DISCOVERIES

(Thousands of Barrels)

Year	Accumulated discoveries up to January 1	Proved reserves January 1	Accumulated production up to January 1	Annual discoveries including new pools, extentions, and revisions	Annual production	Ratio: Proved reserves to annual production	Year
	(1)	(2)	(3)	(4)	(5)	(6)	
1900	3,439,984	2,500,000	939,984	463,621	63,621	42.4	1900
1901	3,903,605	2,900,000	1,003,605	169,389	69,389	42.5	1901
1902	4,072,994	3,000,000	1,072,994	288,767	88,767	34.9	1902
1903	4,361,761	3,200,000	1,161,761	300,461	100,461	32.8	1903
1904	4,662,222	3,400,000	1,262,222	317,081	117,081	29.9	1904
1905	4,979,303	3,600,000	1,379,303	334,717	134,717	27.5	1905
1906	5,314,020	3,800,000	1,514,020	126,494	126,494	30.0	1906
1907	5,440,514	3,800,000	1,640,514	266,095	166,095	23.2	1907
1908	5,706,609	3,900,000	1,806,609	278,527	178,527	22.1	1908
1909	5,985,136	4,000,000	1,985,136	383,171	183,171	22.4	1909
1910	6,368,307	4,200,000	2,168,307	509,557	209,557	20.8	1910
1911	6,877,864	4,500,000	2,377,864	720,449	220,449	21.5	1911
1912	7,598,313	5,000,000	2,598,313	622,935	222,935	23.3	1912
1913	8,221,248	5,400,000	2,821,248	348,446	248,446	21.9	1913
1914	8,569,694	5,500,000	3,069,694	165,763	265,763	20.5	1914
1915	8,735,457	5,400,000	3,335,457	381,104	281,104	19.4	1915
1916	9,116,561	5,500,000	3,616,561	700,767	300,767	19.0	1916
1917	9,817,328	5,900,000	3,917,328	335,316	335,316	17.6	1917
1918	10,152,644	5,900,000	4,252,644	655,928	355,928	17.0	1918
1919	10,808,572	6,200,000	4,608,572	878,367	378,367	17.0	1919
1920	11,686,939	6,700,000	4,986,939	942,929	442,929	15.7	1920
1921	12,629,868	7,200,000	5,429,868	1,072,183	472,183	15.9	1921
1922	13,702,051	7,800,000	5,902,051	357,531	557,531	13.8	1922
1923	14,059,582	7,600,000	6,459,582	732,407	732,407	10.4	1923
1924	14,791,989	7,600,000	7,191,989	613,940	713,940	10.6	1924
1925	15,405,929	7,500,000	7,905,929	1,763,743	763,743	10.5	1925
1926	17,169,672	8,500,000	8,669,672	1,070,874	770,874	11.2	1926
1927	18,240,546	8,800,000	9,440,546	2,601,129	901,129	10.7	1927
1928	20,841,675	10,500,000	10,341,675	1,401,474	901,474	11.9	1928
1929	22,243,149	11,000,000	11,243,149	3,207,323	1,007,323	12.0	1929
1930	25,450,472	13,200,000	12,250,472	1,298,011	898,011	14.9	1930
1931	26,748,483	13,600,000	13,148,483	251,081	851,081	15.6	1931
1932	26,999,564	13,000,000	13,999,564	85,159	785,159	16.1	1932
1933	27,084,723	12,300,000	14,784,723	605,656	905,656	13.4	1933
1934	27,690,379	12,000,000	15,690,379	1,085,065	908,065	13.3	1934
1935	28,775,444	12,177,000	16,598,444	1,219,596	996,596	12.3	1935
1936	29,995,040	12,400,000	17,595,040	1,763,087	1,099,687	11.6	1936
1937	31,758,127	13,063,400	18,694,727	3,723,028	1,279,160	11.2	1937
1938	35,481,155	15,507,268	19,973,887	3,055,233	1,214,355	13.5	1938
1939	38,536,388	17,348,146	21,188,242	2,399,828	1,264,962	14.2	1939
1940	40,936,216	18,483,012	22,453,204	1,894,717	1,353,214	13.9	1940
1941	42,830,933	19,024,515	23,806,418	1,967,009	1,402,228	13.8	1941
1942	44,797,942	19,589,296	25,208,646	1,880,142	1,386,645	14.3	1942
1943	46,678,084	20,082,793	26,595,291	1,486,972	1,505,613	13.3	1943
1944	48,165,056	20,064,152	28,100,904	2,066,983	1,677,753	12.1	1944
1945	50,232,039	20,453,231	29,778,808	2,087,237	1,713,655	12.0	1945
1946	52,319,276	20,826,813	31,492,463	2,831,480	1,733,939	12.3	1946
1947	55,150,756	21,924,354	33,226,402	2,664,438	1,856,107	12.0	1947
1948	57,815,194	22,732,685 ②	35,082,509	..	..	..	1948

(1) Accumulated production up to January 1 plus proved reserves as of January 1.

(2) Figure for 1936 is estimate of *The Lamp* — Standard Oil Company (N. J.); all others from 1935 to 1946 are estimates of the American Petroleum Institute's Committee on Petroleum Reserves. Figures for years previous to 1935 are estimates of the Department of Statistics, API, but are not based on geological surveys.

(3) Accumulated production to January 1 of previous year plus production during previous year.

(4) Proved reserves of following year minus proved reserves of current year plus production of current year.

(5) U. S. Bureau of Mines.

②Estimated.

Source: As noted in footnotes above.

Note: In an attempt to keep 1948 figures on a reasonably comparable basis *The Petroleum Data Book* has included an estimated quantity of 1,245,000 M bbl of cycle-plant and lease condensate reserves with the 21,487,685 M bbl of crude oil reserves. For further explanation of reserve estimates see subsequent pages in this section.

From The Petroleum Data Book, Second Edition, which carries 750 pages of information on the petroleum industry.

DATA ON IMPORTANT OIL FIELDS OF THE UNITED STATES

(Continued)

No.	Year discovered	Field	County	Producing formation	Gravity °API	Productive acres	Estimated Average thickness (feet)
				LOUISIANA (Cont.)			
80	1926	Sulphur Mines	Calcasieu	Mio U, Mio L	17.0-40.0	240	100
81	1926	Sweet Lake	Cameron	Mio U	30.0	1,200	20
82	1935	Tepetate	Acadia	Mio U	41.0	1,000	35
83	1944	Tepetate, West	Jefferson Davis	Mio L	32.0-40.0	1,000	35
84	1938	University	Baton Rouge	Mio U, Mio L	36.0-43.0	1,340	25
85	1936	Valentine	Lafourche	Mio L	33.0	220	35
86	1937	Venice	Plaquemines	Mio U	41.0	1,000	800
87	1937	Ville Platte	Evangeline	Sparta, Wilcox	36.0-60.0	5,240	160
88	1910	Vinton	Calcasieu	Mio U, Mio L, Olig	22.0; 31.0-40.0	600	55
89	1940	West Bay	Plaquemines	(200 ft pay Mio)	34.0	1,000	200
90	1940	West Cote, Blanch Bay	St. Mary	Mio	20.0-32.0	640	30
91	1929	White Castle	Iberville	Mio, Olig	28.0-33.0	650	45
92	1940	White Lake, East	Vermilion	Mio	34.0-40.0	800	30
93	1938	Woodlawn	Jefferson Davis	Mio	34.0-51.0	1,100	30
				MICHIGAN			
1	1937	Adams	Arenac	Traverse, Dundee	37.0	1,220	15
2	1934	Beaverton	Gladwin	Dundee; Dev	41.3	450	12
3	1937	Bentley	Gladwin	Dundee; Dev	41.2	920	3
4	1938	Bloomingdale	Van Buren	Traverse; Dev	42.0	3,000	3
5	—	Buckeye	Gladwin	Dundee	39.0	2,900	11
6	1936	Clayton	Arenac	Dundee	34.2	1,320	12
7	1944	Coldwater	Isabella	Dundee; Dev	47.5	2,440	13
8	1938	Columbia	Van Buren	Traverse; Dev	39.0	1,230	3
9	1935	Crystal	Montcalm	Dundee	43.5	2,180	4
10	1944	Deep River	Arenac	Dundee	—	820	5
11	1942	Evart	Osceola	Dundee; Dev	47.8	1,120	6
12	1942	Fork	Mecosta	Dundee, Detroit River	50.1-54.8	2,600	4
13	1941	Headquarters	Clare Roscommon	Traverse; Dev	40.9	1,600	5
14	1938	Kawkawlin	Bay	Berea; Miss	35.0-38.0	5,000	5, 36
15	1927, 28	Mt. Pleasant	Midland Isabella	Dundee, Traverse	37.4-41.8	8,050	15
16	1927	Muskegon	Muskegon	Traverse, Dundee	37.0	2,700	4
17	1938	New Salem	Allegan	Traverse; Dev	41.8	1,100	6
18	1938	Overisel	Allegan	Traverse; Dev	42.1	2,080	3
19	1931	Porter Yost	Midland	Dundee	40.6	8,440	12
20	1940	Reed City	Osceola	Traverse, Dundee, Detroit River	46.3	5,280	5
21	1925	Saginaw	Saginaw	Berea	46.1	1,800	16
22	1937	Salem	Allegan	Traverse; Dev	38.3	2,500	8
23	1936	Sherman	Isabella	Dundee	42.0	1,220	4
24	1930	Veron-Leaton	Isabella	Dundee	44.1	1,100	3
25	1938	Walker	Kent	Traverse	40.0	5,700	6
26	1933	West Branch	Ogemaw	Dundee	36.8	5,000	5
27	1940	Winterfield	Montcalm	L Detroit River	44.2	80	8
28	1938	Wise	Isabella	Dundee	45.2	1,600	11
29	1932	Yose-Jasper	Midland	Dundee	40.6	—	—
				MISSISSIPPI			
1	1944	Baxterville	Lamar, Marion	U & L Tusc; Cre U	16.0; 53.0	480	30
2	1943	Brookhaven	Lincoln	U & L Tusc; Cre U	27.0-37.0	80	45
3	1943	Cranfield	Adams	Wilcox, Tuscaloosa; Cre U, Eoc	40.5	2,720	30
4	1943	Eucutta	Wayne	Eutaw, Tuscaloosa; Cre U	23.0	3,640	25
5	1944	Gwinville	Jefferson Davis	Eutaw, U & L Tus; Cre U	41.0-53.0	1,120	35
6	1944	Heidelberg	Jasper	Eutaw, Tuscaloosa	22.0-25.0	4,160	25
7	1945	Langsdale	Clark	Eutaw, Cre U	20.0	680	30
8	1944	Mallalieu	Lincoln	Basal, Tusc; Cre U	38.0	80	30
9	1940	Pickens	Yazoo, Madison	Eutaw, Wilburn; Cre U	40.0	1,720	20
10	1939	Tinsley	Yazoo	Woodruff, Selma Ch; Cre U	34.0	12,160	18
				MONTANA			
1	1920	Cat Creek	Petroleum, Garfield	Morrison, Kootenai, Ellis	49.0-52.0	800	45
2	1931	Cut Bank	Toole, Glacier	Kootenai, Madison	20.0-47.0	42,280	35
3	1930, 44	Dry Creek	Carbon	Dakota, Lakota	51.0-53.0	1,280	50
4	1915, 43	Elk Basin L & H	Carbon	Tensleep, Frontier	28.0-43.0	1,400	40-100
5	1922	Kevin—Sunburst	Toole	Kootenai, Ellis, Madison	26.0-50.0	23,000	12
6	1928	Pondera	Teton, Pondera	Madison	32.0	2,600	15
				NEBRASKA			
1	1941	Barada	Richardson	Hunton; Devonian	29.6	500	78
2	1939	Falls City	Richardson	Hunton; Devonian	31.5	1,080	23
				NEW MEXICO			
1	1938	Arrowhead	Lea	Queen, Grayburg; Per	36.0	5,040	50
2	1923	Artesia	Eddy	Yates, Queen, Grayburg; Per	35.0	4,320	25
3	1927	Cooper-Jal	Lea	Seven Rivers, Yates; Per	30.5	5,640	55
4	1929	Eaves	Lea	Yates, Seven Rivers; Per	29.0	1,200	60
5	1929	Eunice-Monument	Lea	Grayburg, San Andres	34.0	40,400	50

From The Petroleum Data Book, Second Edition, which carries 750 pages of information on the petroleum industry.

DATA ON IMPORTANT OIL FIELDS OF THE UNITED STATES

No.	Annual production (thousands of barrels)						Cumulative production thru 1947 (M bbl)	Estimated recovery per acre (bbl)	Number wells producing		
	1942	1943	1944	1945	1946	1947			Total	Flowing	Pumping
							LOUISIANA (Cont.)				
80	776	746	728	787	715	760	20,458	82,075	—	—	—
81	612	648	673	582	559	501	9,096	7,163	17	14	3
82	993	897	731	618	773	747	15,196	14,449	31	18	13
83	—	—	23	1,003	1,828	1,933	4,787	2,854	—	—	—
84	3,286	2,897	2,337	1,985	1,905	2,007	23,124	15,759	—	—	—
85	241	149	187	207	178	204	6,338	27,882	13	6	7
86	1,303	2,131	3,335	3,315	3,028	3,618	19,932	16,314	—	—	—
87	6,440	4,451	3,641	2,917	3,249	2,720	38,193	6,770	—	—	—
88	368	665	1,952	2,706	3,370	3,672	55,887	87,025	—	—	—
89	743	885	1,062	1,221	1,243	1,694	7,267	5,573	—	—	—
90	478	664	746	817	985	1,080	5,233	6,489	—	—	—
91	913	1,297	1,445	1,256	1,020	1,226	12,332	17,071	—	—	—
92	217	562	1,045	1,211	1,426	1,357	5,901	5,680	2	2	0
93	829	947	964	897	736	667	7,787	6,473	16	12	4
							MICHIGAN				
1	1,044	985	1,177	1,195	1,299	1,002	8,254	5,944	—	—	—
2	146	124	98	84	20	17	744	1,616	14	0	14
3	87	96	94	78	77	66	1,135	1,162	37	0	37
4	286	169	125	88	59	95	6,225	2,043	96	0	96
5	393	350	318	332	296	238	20,208	6,886	154	0	154
6	192	180	182	147	141	172	4,477	3,261	55	0	55
7	—	—	68	966	1,598	1,665	4,297	1,079	—	—	—
8	59	66	48	39	40	28	2,183	1,752	101	0	101
9	59	49	43	37	32	25	7,394	3,380	15	0	15
10	—	—	736	1,460	2,409	2,866	7,471	5,616	—	—	—
11	198	1,021	725	452	311	220	2,927	2,417	26	0	26
12	53	798	1,436	1,561	1,354	785	5,998	2,005	—	—	—
13	2,320	1,973	1,212	465	226	169	6,703	4,084	33	0	33
14	493	685	725	656	697	730	4,213	697	—	—	—
15	368	304	285	253	241	233	23,194	2,852	173	0	173
16	26	26	21	19	16	15	6,809	2,516	33	0	33
17	345	220	174	151	123	112	4,069	3,597	63	0	63
18	189	127	86	71	52	55	2,438	1,146	58	0	58
19	1,222	1,019	860	726	462	412	34,829	4,078	216	0	216
20	9,102	7,776	5,194	4,217	3,250	2,212	34,629	6,140	—	—	—
21	20	20	17	15	17	15	1,480	814	28	0	28
22	345	220	174	138	64	59	3,315	1,302	97	0	97
23	168	178	91	66	58	49	4,439	3,598	28	0	28
24	210	177	164	187	152	165	8,227	7,329	54	0	54
25	679	449	357	303	263	245	10,622	1,821	361	0	361
26	333	298	271	245	223	199	6,124	1,185	218	0	218
27	1,259	684	377	221	172	148	3,972	47,800	28	0	28
28	225	177	209	214	202	165	2,695	1,581	56	0	56
29	—	—	—	201	186	182	7,929	—	75	0	75
							MISSISSIPPI				
1	0	0	1	52	1,274	4,955	6,282	2,765	87	—	—
2	0	16	3	47	1,158	4,413	5,637	15,300	131	—	—
3	0	13	525	2,103	4,473	5,544	12,658	2,615	78	—	—
4	0	2	454	2,060	2,391	2,520	7,426	1,348	121	—	—
5	0	0	3	107	147	339	596	229	52	—	—
6	0	0	1,441	2,898	4,104	5,050	13,493	2,030	137	—	—
7	0	0	0	95	380	376	851	990	—	—	—
8	0	0	32	117	172	2,073	2,394	4,013	—	—	—
9	430	1,459	2,142	2,073	1,783	1,517	9,897	4,872	—	—	—
10	28,177	17,264	11,803	9,332	8,063	6,741	100,985	7,750	—	—	—
							MONTANA				
1	138	119	115	131	483	586	16,194	19,510	159	—	
2	5,522	5,339	5,443	4,875	4,571	4,243	56,037	1,225	1,100	—	—
3	107	95	94	163	158	129	2,607	1,936	8	—	—
4	16	246	686	940	1,371	1,725	5,815	2,921	56	—	—
5	1,960	1,833	1,914	1,909	1,795	1,624	49,969	2,102	1,501	—	—
6	262	209	239	259	303	317	7,548	2,781	181	—	—
							NEBRASKA				
1	373	206	115	106	70	62	966	1,808	12	0	12
2	864	426	285	192	160	141	4,116	3,681	35	0	35
							NEW MEXICO				
1	1,199	1,707	1,948	1,846	1,695	1,546	13,068	2,286	—	—	—
2	199	173	159	162	151	—	—	1,124	—	—	—
3	989	933	728	757	735	726	24,799	4,268	—	—	—
4	228	347	379	321	326	326	3,934	3,007	—	—	—
5	10,947	13,699	13,909	12,760	11,655	11,335	173,422	4,012	—	—	—

(Continued)

From The Petroleum Data Book, Second Edition, which carries 750 pages of information on the petroleum industry.

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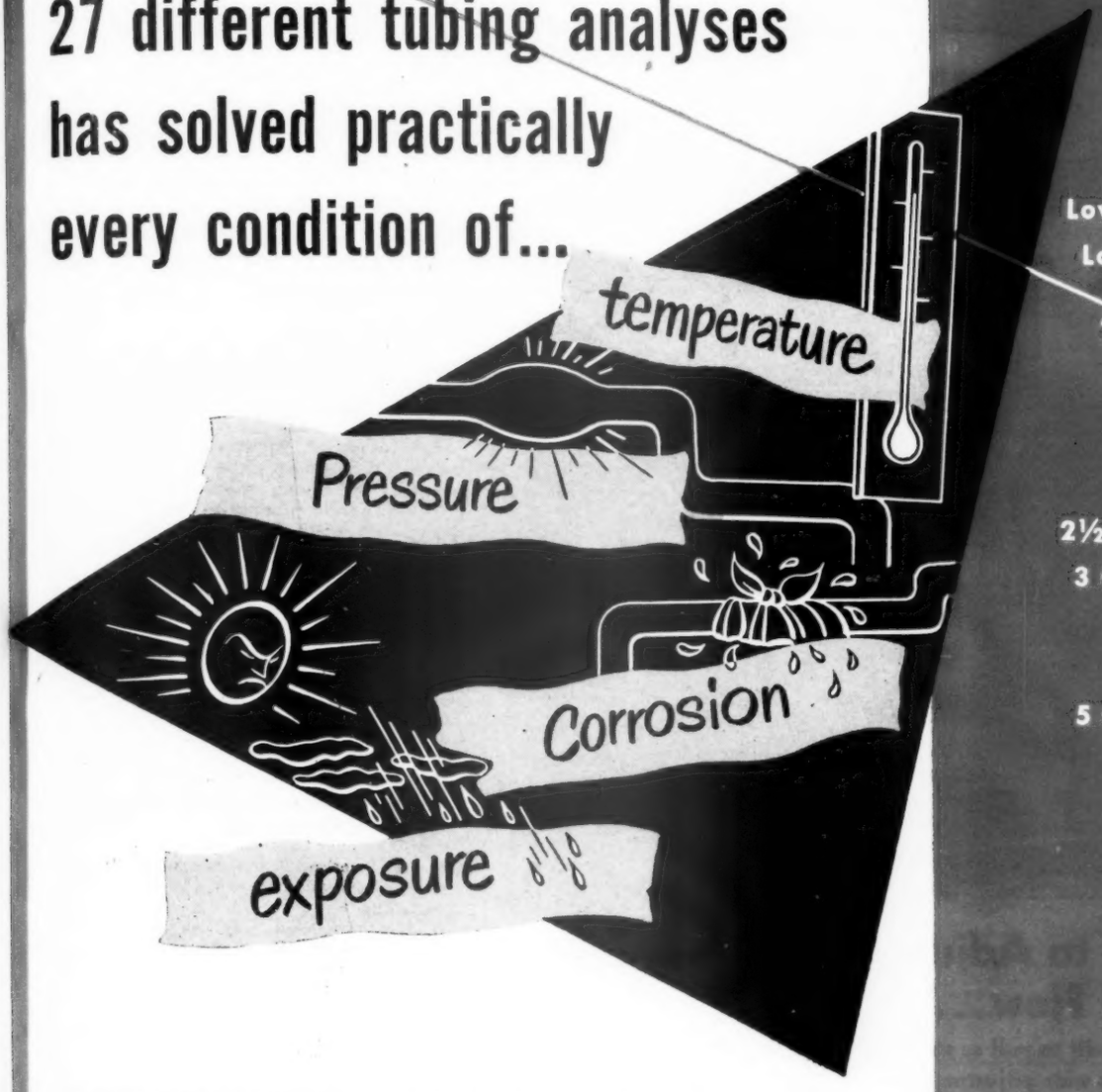

Low Carbon
Low Carbon, ½ Mo
Low Carbon, 1 Mo
½ Cr, ½ Mo
1 Cr, ½ Mo
1¼ Cr, ½ Mo
2 Cr, ½ Mo
2¼ Cr, 1 Mo
2½ Cr, ½ Mo, ¾ Si.
3 Cr, ½ Mo, 1¼ Si
3 Cr, 1 Mo
5 Cr, ½ Mo
5 Cr, ½ Mo, 1½ Si
5 Cr, ½ Mo, Ti
6 Cr, ½ Mo
7 Cr, ½ Mo
8 Cr, 1 Mo
9 Cr, ½ Mo
9 Cr, 1 Mo
12 Cr, Al
17 Cr
27 Cr
18-8
18-8 Ti
18-8 Cb
18-8 Mo
25-20

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MEETINGS

July 19-20—Western Petroleum Refiners Association (regional meeting) Joint Technical-Industrial Relations Meetings, Broadview Hotel, Wichita, Kansas.

July 31-Aug. 3—Wyoming Geological Association, Rawlins, Wyoming.

Aug. 13-15—Society of Automotive Engineers, Inc., West Coast Meeting, Olympic Hotel, Seattle, Washington.

Aug. 17—Western Petroleum Refiners Association, Leonard Refineries Auditorium, Alma, Michigan.

Aug. 27-29—Eleventh Annual Appalachian Gas Measurement Short Course, West Virginia University, Morgantown, West Virginia.

Sept. 3-7—American Chemical Society, 120th National Jubilee Meeting, Hotel Statler, New York City.

Sept. 4-6—Pacific Coast Gas Association, Annual Convention, Fairmont Hotel, San Francisco, California.

Sept. 5-8—Oil Industry Information Committee, Waldorf-Astoria Hotel, New York, N. Y.

Sept. 6-7—Michigan Petroleum Association (Annual Fall Convention), Ramona Park Hotel, Harbor Springs, Michigan.

Sept. 8-9—International Union of Pure and Applied Chemistry (16th Conference), Hotel Statler, New York City.

Sept. 9-18—National Petroleum Convention (Venezuela), Caracas.

Sept. 10—New York Oil Heating Association, Inc., Hotel Statler, New York City.

Sept. 10-14—Instrument Society of America, National Conference and Exhibit. Sam Houston Coliseum, Houston, Texas.

Sept. 10-14—American Society of Mechanical Engineers, Industrial Instrument and Regulators Division, Coliseum, Houston, Texas.

Sept. 12—American Petroleum Institute (Lubrication Committee Meeting), Traymore, Atlantic City, N. J.

Sept. 12-14—National Petroleum Association, Hotel Traymore, Atlantic City, New Jersey.

Sept. 16-19—American Institute of Chemical Engineers, Regional Meeting, Sheraton Hotel, Rochester, New York.

Sept. 17-18—American Gas Association (Accident Prevention Committee, Safety Conference). Hotel Phillips, Kansas City, Missouri.

Sept. 17-19—American Institute of Chemical Engineers, National Meeting, Sheraton Hotel, Rochester, New York.

Sept. 20-21—Western Petroleum Refiners Association, Hotel Henning, Casper, Wyoming.

Sept. 21-23—Louisiana Golden Oil Jubilee, Jennings, Louisiana.

Sept. 21—Oklahoma Utilities Association, Gas division, Biltmore Hotel, Oklahoma City, Oklahoma.

Sept. 24-25—American Association of Oil Well Drilling Contractors, Eleventh Annual Meeting, Fort Worth, Texas.

Sept. 24-26—American Society of Mechanical Engineers (6th petroleum mechanical engineering conference) Mayo Hotel, Tulsa, Oklahoma.

Sept. 25-28—The American Society of Mechanical Engineers (Fall Meeting), Radisson Hotel, Minneapolis, Minn.

Oct. 3-5—American Institute of Mechanical and Metallurgical Engineers, petroleum branch, fall meeting, Oklahoma City, Oklahoma.

Oct. 4-5—California Natural Gasoline Association (26th Annual Fall Meeting), Ambassador Hotel, Los Angeles, California.

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For portable air compressors, jackhammers, rugged industrial and construction work. Smooth, black, non-porous tube resists heat and oil. Carcass: multiple ply, rubber-impregnated, rugged woven fabric. Tough black cover resists weather and abrasion. Stocked sizes: ½", ¾", 1". 200 lbs. working pressure. Maximum length 50'.

VIM AIR

For general industrial use, on compressors and pneumatic tools. Black tube resists oil and heat. Husky cotton yarn braids. Smooth, red cover resists weather, abrasion. 8 sizes stocked, ¼" 2-braid to 1" 3-braid. Working pressures 150 to 225 lbs. Maximum length 500'.

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Oct. 8-9—Texas Mid-Continent Oil and Gas Association, Annual Meeting, Beaumont, Tex.
Oct. 8-10—The American Oil Chemists Society (Fall Meeting), Edgewater Beach Hotel, Chicago, Illinois.
Oct. 14-19—World Metallurgical Congress, Detroit, Michigan.
Oct. 14-20—Oil Progress Week.
Oct. 15-17—American Gas Association, Annual Convention, St. Louis, Missouri.
Oct. 15-17—American Petroleum Credit Association (27th Annual Conference), Adolphus Hotel, Dallas, Texas.
Oct. 15-17—American Gas Association (Annual Convention), Kiel Auditorium, St. Louis, Mo.
Oct. 15-19—National Metal Congress and Exposition, American Society for Metals, American Institute of Mining and Metallurgical Engineers, and Society for Non-Destructive Testing, Hotel Statler, Book-Cadillac, and Detroit-Leland, Detroit, Michigan.
Oct. 18—Institute of Gas Technology, Annual Meeting, Chicago, Illinois.
Oct. 18-20—National Association of Corrosion Engineers, South Central Region, Corpus Christi, Texas.
Oct. 22-23—Independent Petroleum Association of America (annual meeting), The Shamrock, Houston, Texas.
Oct. 29-30—Society of Automotive Engineers, Inc. (national diesel engine meeting), The Drake, Chicago, Illinois.
Oct. 31-Nov. 1—Society of Automotive Engineers, Fuels and Lubricants, Drake Hotel, Chicago, Illinois.
Nov. 3-8—Oil Industry Information Committee, Stevens Hotel, Chicago, Illinois.
Nov. 5-8—American Petroleum Institute, Annual Meeting, Palmer House and Stevens Hotel, Chicago, Illinois.
Nov. 15-17—Rocky Mountain Oil and Gas Association (Annual Meeting), Cosmopolitan Hotel, Denver, Colorado.
Nov. 19-20—Society of Exploration Geophysicists, Annual Mid-west Regional Meeting, Baker Hotel, Dallas, Texas.
Nov. 25-30—The American Society of Mechanical Engineers, Annual Meeting, Atlantic City, New Jersey.
Nov. 26-Dec. 1—23rd Exposition of Chemical Industries, Grand Central Palace, New York New York.
Dec. 2-5—American Institute of Chemical Engineers, Annual Meeting, Chalfonte-Haddon Hall, Atlantic City, New Jersey.

NOMADS TO MEET

New York, N. Y., Chapter, First Monday of the Month, Louis Sherry's, New York, N. Y. Secretary Fred J. Jobst, c/o Val. A. Wittich, Jr., 30 Rockefeller Plaza, New York 20, New York.

Houston Chapter, Second Monday of the Month, Ye Olde College Inn, Houston, Texas. Secretary E. F. Baldwin, Hughes Tool Company, Box 2539, Houston, Texas. WO-3101.

Los Angeles Chapter, Second Wednesday of the Month, Jonathan Club, Los Angeles, Calif. Secretary W. A. Wilson.

Tulsa Chapter, Third Friday, "After Five" Room, Hotel Tulsa. Secretary R. E. Kirberger, Unit Rig Manufacturing Company, Tulsa, Oklahoma.

Dallas Chapter, Dallas, Texas, First Monday of the Month. Except October 29, Dallas (Nov. Meeting). Secretary Gene Shiels, 205 Irwin-Keasler Building, Dallas, Texas, Riverside 4042.

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for safe and efficient handling of LP-gases

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These new Crane composition disc valves—in globe, angle, and lift check patterns—carry "UL" approval for use on all common commercial forms of Liquefied-Petroleum Gases. Crane Quality construction gives added assurance of safe and efficient handling of hazardous LP-Gases.

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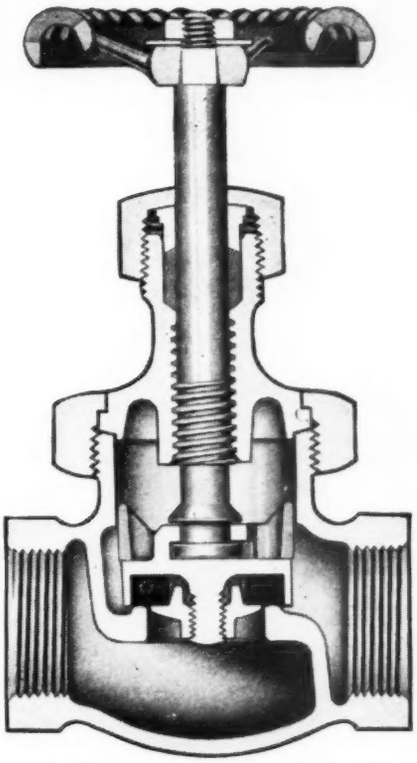

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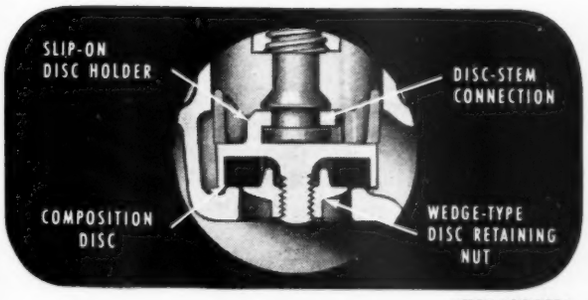

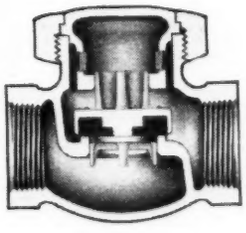

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LETTERS *to the* EDITORS

TWO VIEWS ON DEEP DRILLING AND EXTENT OF ITS SUCCESS

To The Petroleum Engineer:

In regard to Miss Ernestine Adams' article entitled "Treasure in the Depths," published on page A-33, *et seq.*, in THE PETROLEUM ENGINEER for December, 1950, I have made a rather thorough study of the deeper new-field wildcats drilled in the years 1944 to 1949, inclusive. I do not have satisfactory information on those which were drilled before 1944.

My figures show—and please remember that I am speaking only of new-field wildcats, or rank wildcats, and not of any deeper-pool tests or other tests which were drilled to considerable depths—that there were 97 producers and 361 dry holes drilled between depths of 10,000 and 10,999 ft; there were 73 producers and 222 dry holes drilled between depths of 11,000 and 11,999 ft; and there were 69 producers and 218 dry holes drilled to depths of 12,000 ft or deeper.

Under "producers" I am including oil wells, gas wells, and gas-plus-condensate wells. The breakdown for these producers was as follows: Between depths of 10,000 and 10,999 ft, 48 oil wells, 12 gas wells, and 37 gas-plus-condensate wells; between 11,000 and 11,999 ft, 40 oil wells, 10 gas wells, and 23 gas-plus-condensate wells; and to 12,000 ft or deeper, 34 oil wells, 4 gas wells, and 31 gas-plus-condensate wells.

I have had the individual well records checked by three of our outstanding geologists who are connected with major companies which keep full records of this kind, and with their help, I have classified the producers according to my system, which has been used in the articles on exploratory drilling, as follows: Those which are estimated to have discovered fields which will ultimately produce 50 million barrels or more are labeled *A;* from 25 to 50 million barrels, *B;* from 10 to 25 million barrels, *C;* from 1 to 10 million barrels, *D;* one million barrels or less, *E;* 10 billion cubic feet or more of gas, *X;* less than 10 billion cubic feet of gas, *Y;* and those which were at first thought to be producers, but have been abandoned, *F.*

I have had estimates made both of the gas and of the natural gas liquids where the well or the discovered field is known to have reserves of both. Following is the summary based on these figures which I have for estimated total ultimate production of the fields discovered by rank wildcats over 12,000 ft deep in the year 1944 to 1949, inclusive:

As successes we may include:

8 fields estimated as likely to produce 1 million barrels of oil or more (A, B, C, and D of the classification indicated above).

3 fields likely to produce 10 billion cubic feet of gas or more (X)

2 fields estimated as likely to produce 10 billion cubic feet or more of gas plus 1 million barrels or more of condensate

4 fields likely to produce 10 billion cubic feet or more of gas but less than 1 million barrels of condensate

5 fields likely to produce less than 10 billion cubic feet of gas, but more than 1 million barrels of condensate

The total of these "successful" fields is 22.

As unsuccessful we have:

218 dry holes

18 fields estimated as likely to produce less than a total of 1 million barrels of oil (E)

7 fields which were at first thought to be successful but were abandoned (F)

6 fields likely to produce less than 10 billion cubic feet of dry gas

16 fields estimated as likely to produce less than 1 million barrels of condensate and less than 10 billion cubic feet of gas

The total of these unsuccessful fields is 265.

Comparing the successful fields (or successful deep holes) with those which were unsuccessful, we therefore have 22 of the former as against 265 of the latter, or 1 successful deep new-field wildcat (over 12,000 ft deep) for every 12.45 failure which were drilled to similar depths.

This is certainly a very different story from that which Miss Adams brought out in your December number. As you will note I have made this study only of the 12,000 ft and deeper holes, but I feel sure that a similar study made of all wells drilled below 10,000 feet would yield a much worse picture of the ratio of success to failure than was indicated by Miss Adams.

F. H. Lahee
Geological and Research Counselor
Sun Oil Company
Dallas, Texas

Editor's Note:

The differences in time periods and more particularly the difference in terms and objectives make it virtually impossible to compare Dr. Lahee's deep drilling figures and those I used in "Treasures in the Depths." My opinion is that our statistics are more similar than our semantics. Or more accurately, Dr. Lahee is classifying some very definite trees whereas I was describing the forest.

Although not comparable, I see nothing irreconcilable between the two sets of data. I stated plainly that I counted new oil or gas sands as discoveries. I followed the classification of the operators of each deep well in most cases. Where Dr. Lahee selected 287 "rank" wildcats to examine over a period of six years, I considered 599 wildcats, or all those drilled from 1935 to 1950. These included field wells that were wildcatting only in depth. I did make one arbitrary exception and counted as field wells the deep tests that were completed in more shallow proved sands.

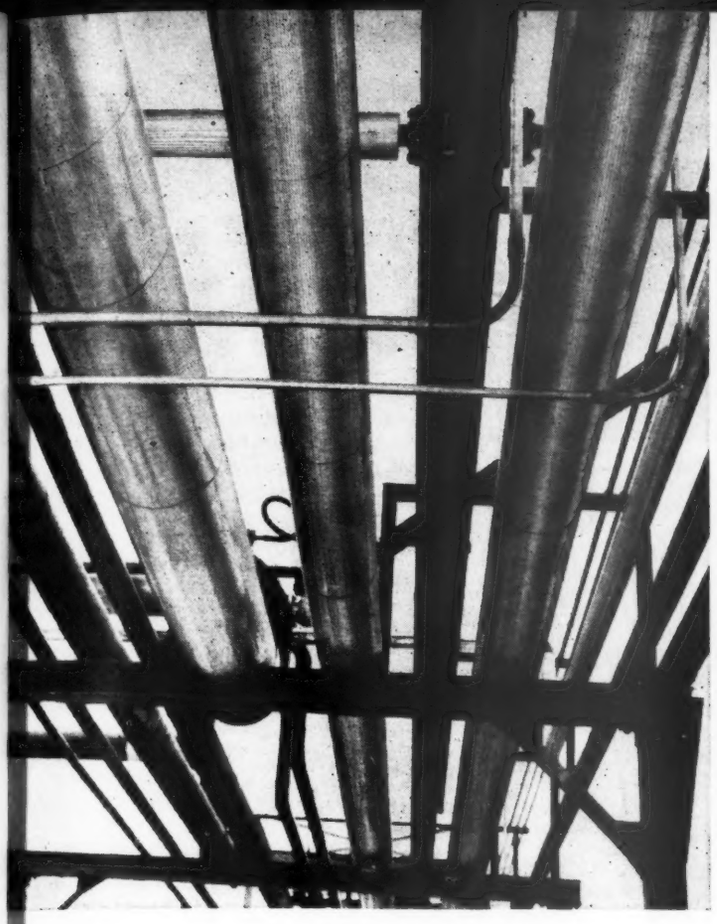
Of these 599 deep wildcats the operators themselves stated that 207 found new oil or gas.

I made no estimate of reserves found by deep wells. That is becoming a hazardous occupation in these days of chemically forced production and pressure maintenance. I know of one deep well on my list as a dry hole in 1948, which when given the Hydrafrac treatment in 1950 brought in a new oil field.

The main purpose of my article was to indicate the decisive trend toward deep drilling and to gage its results within the limits of whether oil and/or gas was found. My conclusions were simply that there is oil down there. It can pay off. It is a risk and it costs plenty but you may have a better chance of turning up a producer than you do in shallower depths. You test more formations and you may complete a deep test in a known field as a development well if it is unsuccessful as a deep wildcat.

On the other hand, Dr. Lahee's figures are pretty grim especially in view of two factors: (1) Most deep wells are drilled where the best petrolific areas are judged to be, and (2) the specific site of deep wells is given extreme consideration because of the high costs involved.

The majority of deep wells are in Louisiana where all discoveries are



This close-up clearly shows the ribs or corrugations which add strength to Childers Jacketing and also make it form more easily around lines. Aluminum strapping and seals are a quick, inexpensive way to attach the jacketing. They can be used without any special tools and take no special training for the installers.

Does long lasting aluminum cost too much for covering your insulated lines? Not when you specify this new type weatherproof jacketing. It has been specially developed to cost little more than ordinary temporary jacketing materials.

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AT LAST an aluminum jacket has been "engineered" especially to protect outdoor lines in refineries and chemical plants. It is the first "permanent-type" jacketing that offers both low initial cost and low application cost.

After two years of tests and major installations at 431 outdoor locations in refineries, power plants, and chemical plants, the Childers Manufacturing Co. of Houston has rung up an impressive cost-cutting record with their Childers Aluminum Jacketing.

Secret behind this low cost is the thin aluminum sheet—.006" thick—which is the weather-protecting sheath of the jacketing. It is ribbed (as pictures show) for extra strength and to facilitate forming around the line. This aluminum has proved thick enough to resist weathering and usual abrasion, but costs much less than heavier aluminum sheets.

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The Childers jacketing can be removed and re-used.

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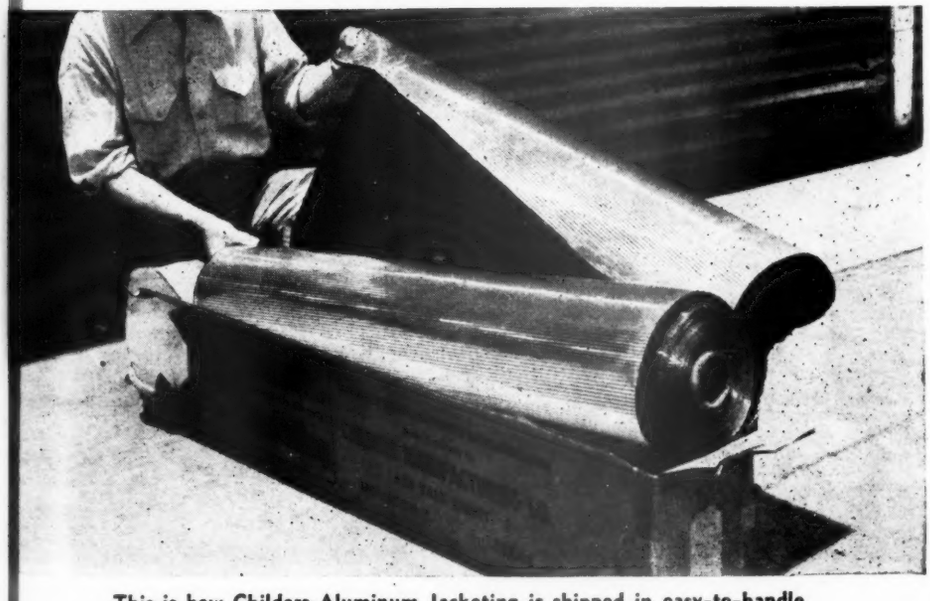

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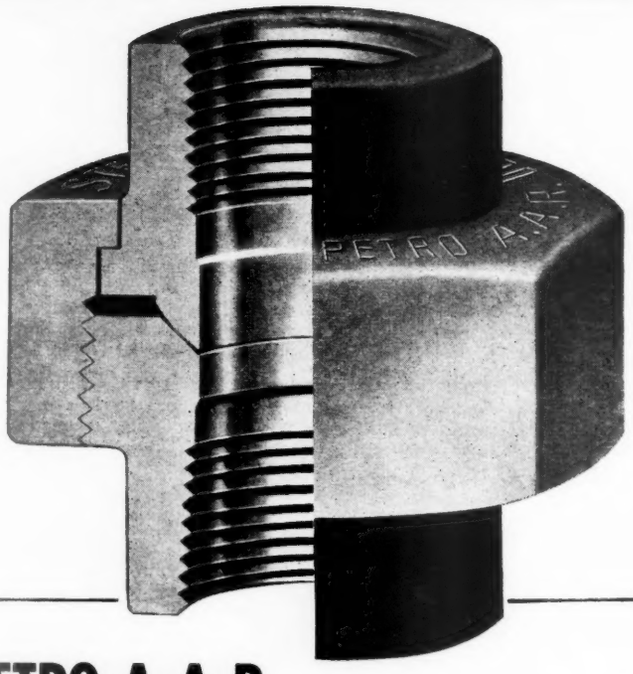

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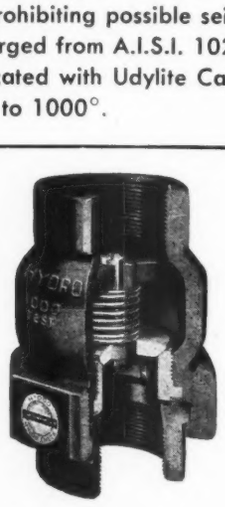

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Producing Digest

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The Petroleum Engineer
July 1, 1951

HISTORY OF WATER-FLOODING†

Since the first "accidental leaks" in the early 1900's flooding operations have expanded to include deep as well as shallow fields and water injection in new reservoirs as well as secondary projects.

HARRY H. POWER*

WHENEVER one discusses water-flooding as a means for the secondary recovery of petroleum, it is customary to make reference, directly or indirectly, to the practices and results that have been established over an authoritative number of years in the state of Pennsylvania. From the standpoints of total production derived, investigations and research established, and special techniques developed, Pennsylvania is the most important state in the country to be associated with secondary-recovery operations, and water-flooding in particular.

The Bradford district, of first importance in Pennsylvania in water-flooding operations, consists of the large and very important Bradford field and the Guffey and Burning Well fields nearby.[1] These fields, all in McKean County, produce from the Bradford Third Sand. Although water-flooding in this area has been particularly effective, air and gas repressuring have not been successful.

Commenting on the original floods in Pennsylvania, David Dennison, famed oil editor wrote in 1921:[2] "John Van Tine, one of the best known oil men in northwestern Pennsylvania, says the flood started about 25 years ago (1896) on the Balton lease in the vicinity of Aiken in McKean County. The lease had fallen off in its productiveness and operations had been practically abandoned. Casing was pulled up from some of the wells. . . By withdrawing the casing, water from the levels above the producing sand poured into the holes and the flood was on. Later, when drilling was done in advance of the 'pulled' wells, large production for the region was an agreeable surprise for the producers."

A law was enacted early in the oil production history of Pennsylvania, which required that abandoned or dry wells be so plugged as to prevent the seepage of water into the sand and thereby prevent the "bad effect" on production operations predicted by the more pessimistic operators. As the law apparently applied to abandoned or dry wells, it was assumed by the oil men that no reference was made to a producing well, and hence the deduction that water flooding was prohibited.[3]

Many "accidental" leaks occurred in casing and tubing, and as a result the production of the field began to increase gradually, beginning with the year 1906. It is reported that many an individual made a living by cutting and ripping casings at night.[2] Other wells were drilled at relatively equal distances around the "offending" well, which established the first pattern for the "circle" flood.[3]

As the movements of water could not be predicted or controlled by the random dumping of old wells it was not uncommon to drill into water when oil was anticipated. Hence, the Forest Oil Company introduced the first "line" flood in 1921, which proved to be superior to the "circle" flood, and was adopted generally throughout the Bradford field. The line flood required that the input wells be placed in an initial line with producing wells arranged in rectangular or staggered patterns on either side.[4]

At the suggestion of Paul D. Torrey, Arthur Yahn experimented with more intensive well patterns in 1927 in an effort to obtain better control through the use of the five-spot pattern.[24] In this arrangement, four input wells were placed at the corners of a square, with the producing well at the center. Although the four, seven, and nine-spot patterns have been used to some extent, the five-spot pattern is the principal one now used in Bradford with the result that more water is introduced into a tight sand in a given time. The depletion of the property is thereby hastened with a resulting greater turnover of the capital invested.

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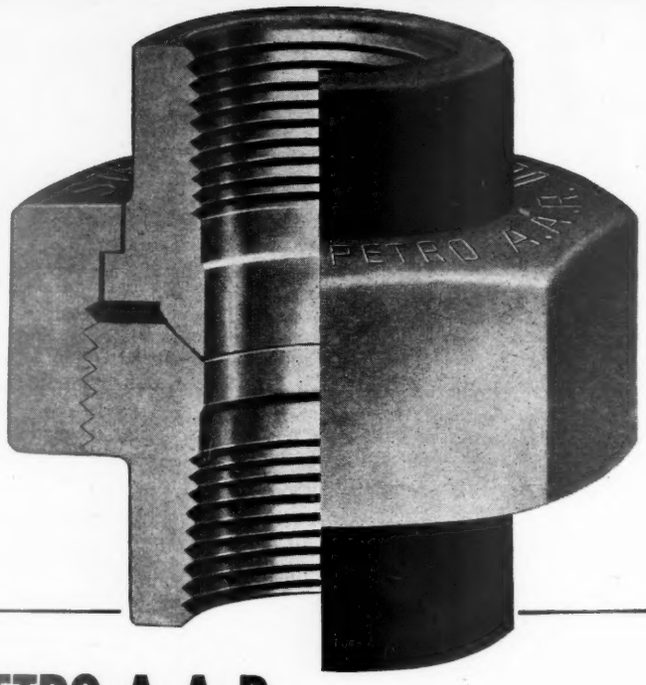

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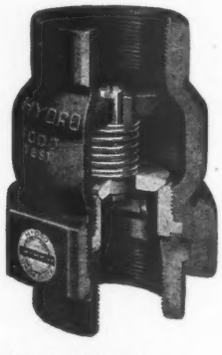

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*Department of Petroleum Engineering, The University Press, Austin, Texas.

flooding practice, and by means of this special act gave permission to leave wells open for the introduction of water with the provision that they be so tubed and packed as to prevent the injected water from entering other oil or gas bearing sands above or below the one subject to flood.[3]

Bradford Production

Many wells were drilled in the Bradford field following the completion of the first large producer in 1875.[4] A peak annual natural output of 22,945,000 bbl was obtained in 1881, which declined rapidly to less than 2,000,000 bbl yearly by 1907. The total of 63,000,000 bbl produced in the three-year period 1881-1882 was 74 per cent of the total production of the United States and 64 per cent of the world's production. This productive capacity established an all-time record for the relative importance of a single field on world supply. McKean County has produced over 80 per cent of the oil produced in Pennsylvania since 1933.

The Bradford district has produced about 511,000,000 bbl of crude oil in the period from 1871 to January 1, 1948.[5] Of this total, natural production has yielded 250,000,000 bbl, and water flooding 235,000,000 bbl.[2] Buckwalter extrapolated the production decline curve of recent years and showed that the Bradford district should produce about 194,000,000 bbl of additional crude oil in the 30-year period beginning January 1, 1948.[5] He estimated that 10,000 bbl of oil daily could be produced if the new wells could be drilled at the rate of about 2000 wells yearly up to January 1, 1958, and that this rate would not decrease to less than 1000 wells yearly by 1978. At least 45,000 acres of oil property suitable for 5-spot development would be necessary to maintain this high rate of drilling. This area would include 25,000 acres to be drilled in the re-development of presently 5-spotted properties that were already flooded.

Continuing with his analysis from actual and projected data, Buckwalter estimated that the total oil production from water-flooding operations in the Bradford district between the years 1907 and 1977 amounted to 456,000,000 bbl. Based on a total cumulative figure up to the year 1947 of 98,000 acres, a water-flood yield of 4700 bbl per acre was expected by the end of 1977, and 5000 bbl per acre by 1990.

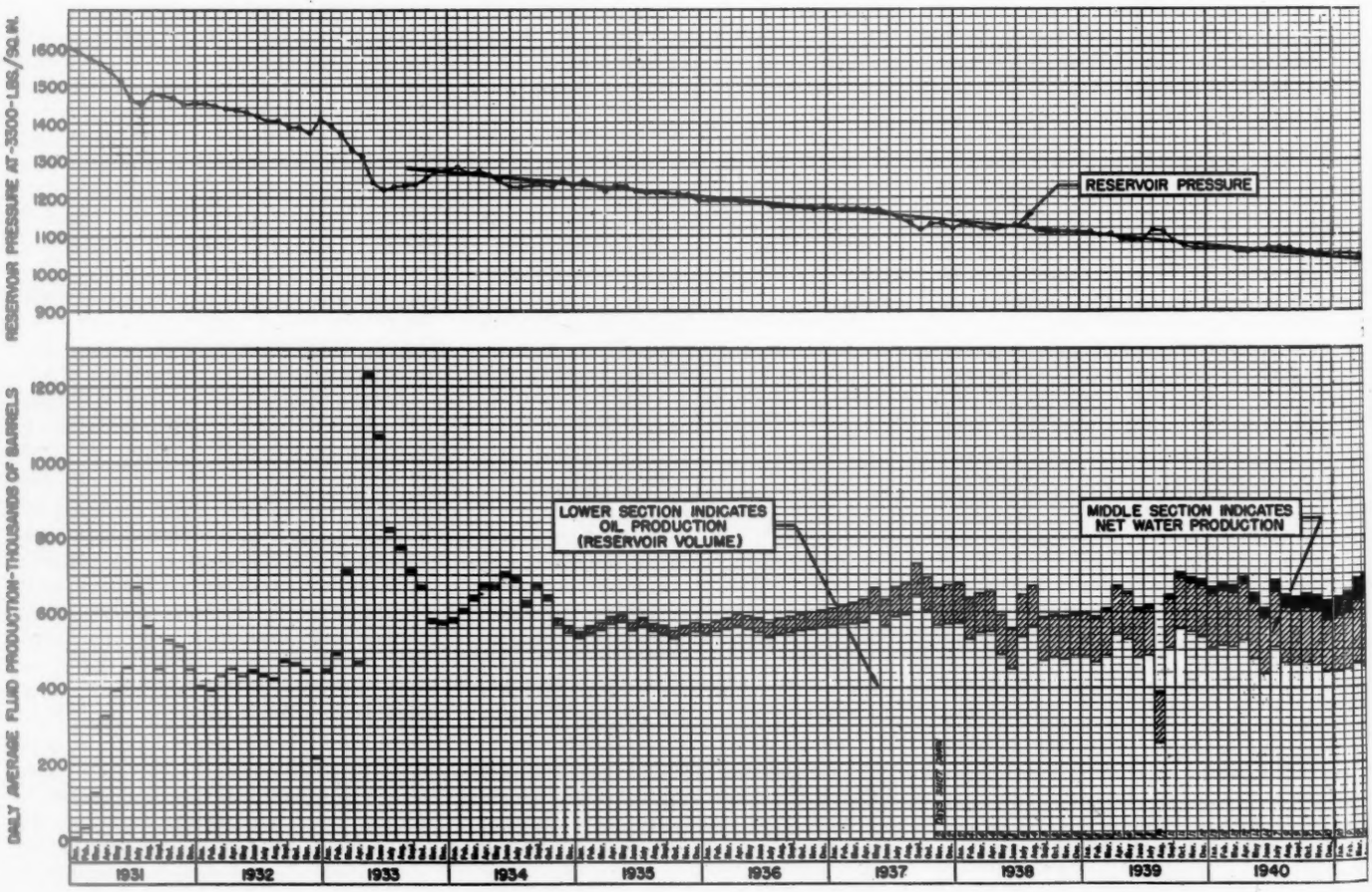
Another authority, Ralph T. Zook, has stated that "the Bradford field has yielded 3000 bbl per acre by primary production, will recover an additional 4000 bbl by water-flooding; but, even after that has been done, there will be 8000 bbl per acre remaining in the sands. If you like your statistics in percentages, they are: 20 per cent primary, 27 per cent by water-flooding, and 53 per cent remaining."[2]

Yearly production today in the Bradford field would likely be less than one-half million barrels had natural depletion occurred. With the water flood, however, the yearly production is near 12,000,000 bbl, which represents a 24-fold increase in current annual production rate.[3]

The water flood has produced nearly as much oil during the past 24 years as was produced naturally during the preceding 55 years.[3]

No history of water-flooding operations is complete without some reference to the role of the petroleum engineer in the development of techniques for the estimation and evaluation of recoverable oil, and for the actual recovery of oil over and above the quantities realized by normal depletion methods. Aptly, this additional oil has been termed "the engineers' oil," and it is in Pennsylvania that full recognition must be acknowl-

Performance record for East Texas field shown graphically below. This is the



edged for the earliest contributions and continued catalysis in engineering investigational and research activities.

Although the diamond core drill had been used extensively in this country for prospecting and ore evaluation, it was not until the summer of 1924 that it was used to investigate oil bearing sands in a well one-half mile west of Custer City.[3] Dr. A. F. Melcher of the U. S. Geological Survey examined cores from this well and determined their porosity. He is thereby credited with the initial development of laboratory techniques for core analysis.

Evaluation Methods

The first modern cable-tool core barrel was used in Bradford in 1928 by George W. Bovaird, Jr., and Clarendon M. Streeter.[6] Simultaneously, Paul D. Torrey is credited with the establishment of the first commercial core laboratory, and in 1930, he reported evidence of interstitial water in the Bradford sand. In 1933 and 1934 permeability variations were exhibited graphically as core profiles of the individual wells, and a direct relationship was shown to exist between permeability profile and flooding efficiency. Chip coring and the evaluation of recovery possibilities therefrom in the laboratory were initiated in 1937.[3]

It is outside the purpose of this paper to recount in full the results of engineering investigation and research in water-flooding from the first efforts up to the present time. A few general observations concerning research in the Pennsylvania area are considered to be in order, however.

On July 1, 1929, a bill was passed by the legislature, which provided an appropriation of $50,000 to be divided equally between production and refining studies at the Pennsylvania State College.[3] In 1933 the Bradford district Pennsylvania Oil Producers Association established their first project in secondary recovery research, and, as the program advanced, the Pennsylvania Grade Crude Oil Association contributed to its support and established the first research in air-gas repressuring at the college.

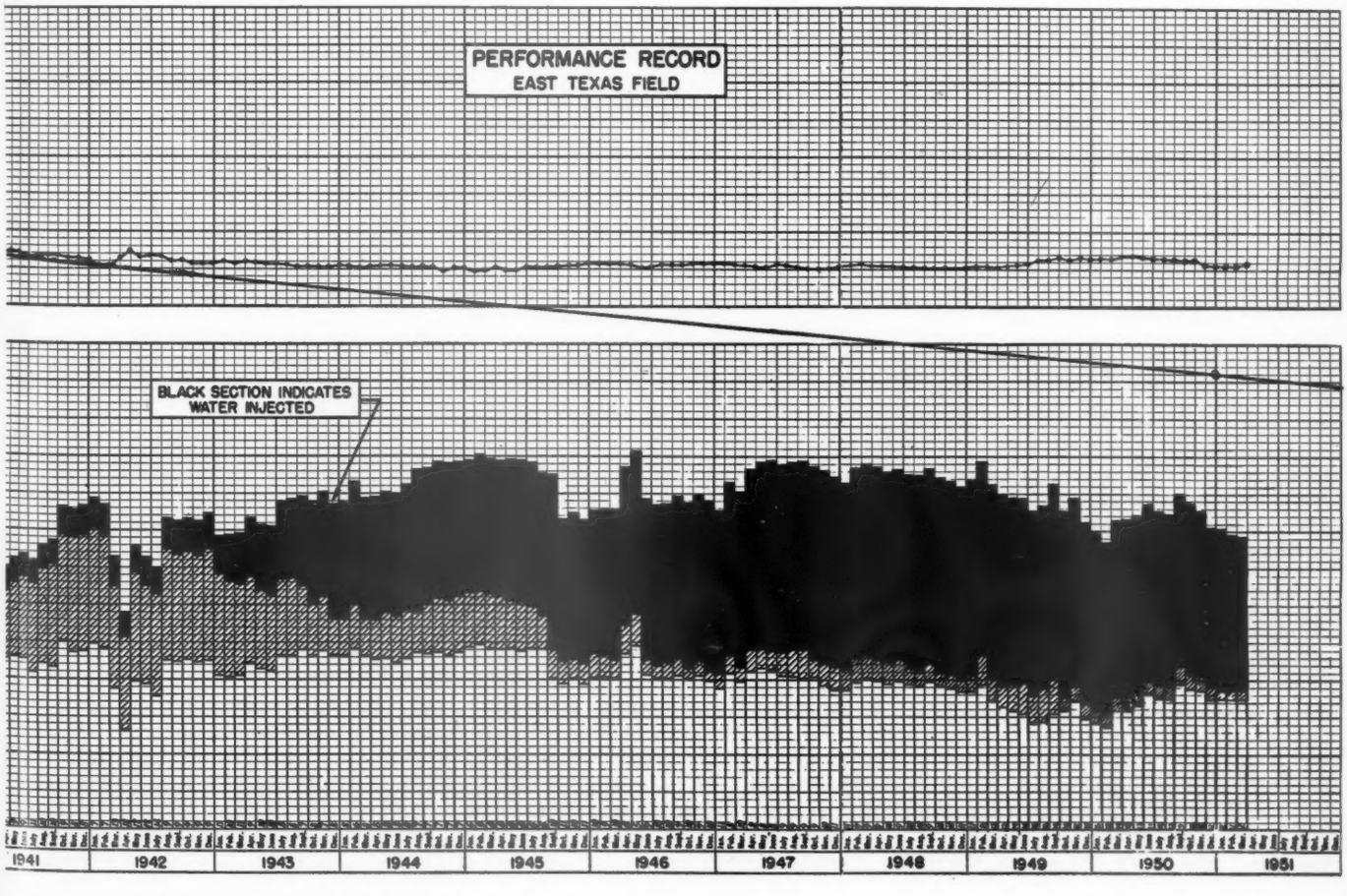
In 1943 that association assumed responsibility for providing funds to be matched by the state for research work at both Pennsylvania State College, and a special laboratory at Bradford, Pennsylvania.[7] In October, 1944, the association voted to provide $50,000 annually over a three-year period for these purposes, with industry providing a like amount. In 1947, the association renewed its sponsorship of secondary recovery research for a 3-year term beginning in 1948.

As the reservoirs in New York are not suitable for air and gas repressuring, water-flooding is used almost exclusively as a secondary method for increasing oil recovery.[1] The expansion of water-flooding operations in New York parallels closely that of the nearby oil fields of Bradford, the first notable effects having been observed in 1912. The annual production of oil has been increased about 5 times over the annual production of 1920, and it is estimated that the ultimate recovery will at least be doubled. Some areas have been found to be exceptionally prolific, while others are of average productivity. Large areas, however, are characterized by sands of lessened continuity and greater variation in lithology, and, accordingly, are of marginal quality.

Kansas Water-Flooding

Most of the producing oil reservoirs in Kansas are of the limestone and dolomite types, but artificial water-flooding is carried on most extensively in the Pennsylvanian standstone reservoirs, and to a lesser degree in

largest project of its kind and has demonstrated the effect of constant water flooding.



coarse detrital rocks such as the Mississippian "chat."[8]

It is believed that intentional, but haphazard, water floods established by pulling of casing or improper abandonment of wells, have been in operation in the shallow Sedan-Peru area of Chautauqua County, Kansas, as far back as 1916.[1] It was not until after the first successful systematic floods in Oklahoma were effective, however, that active water-flood developments were commenced in the fields of southern Kansas. This occurred in 1935 when the Kansas legislature enacted a law authorizing water-flooding.[8] Simultaneously, projects were planned in Greenwood, Chautauqua, and Linn counties. As the Pennsylvania "shoestring" sands are, in general, relatively free from clay partings, selection of suitable reservoirs for water-flooding was made in horizons ranging from about 400 to 1950 ft deep.

An initial project in the Humboldt-Chanute field was started in 1937, some nineteen months after the beginning of the York State Oil Company project in Greenwood County, which introduced the systematic water flooding of oil sands in the state of Kansas. The project at Lynde, et al, covering over 1020 acres, is now the largest in the field.[9] There were 1500 acres in three major projects at the end of 1949, which produced more than 450,000 barrels of oil, with 575,000 bbl estimated for 1950.[9]

As development in this field has been so recent, water-flood recovery as estimated from decline curves has been difficult. Production records of one lease in the original development indicate an ultimate recovery of 6200 bbl of oil per acre. Although the recovery throughout the field will probably not be as high, the records indicate that flooding has been highly successful.[9]

The Clopton Unit consists of 200 acres situated in Greenwood County in the southern portion of the old Sealy-Wick pool.[10] Production is from the Bartlesville sand found at a depth of 1,900 ft. The area was unitized by Cities Service Company, et al, on November 1, 1945. A five-spot flood pattern was adopted with 10-acre spacing to like wells. Flooding was initiated in February 1946, and two years later, the average daily production increased to 550 bbl from the 27 bbl existing at the beginning of operations.

Sweeney[11] has estimated that a total of 110,350,000 bbl of oil will be recovered by the application of secondary recovery methods in the eastern Kansas shallow area. The total number of productive acres in the area at the time of his report in 1949 was 92,400, and the total number of flooded and floodable acres was estimated to be 46,200. The total cumulative production to January 1, 1948, was estimated at 164,192,000 bbl, of which 133,338,000 bbl represented primary recovery, and 30,854,000 bbl were estimated for secondary recovery. The water-flood reserves as of January 1, 1948, were estimated to be 79,496,000 bbl.

In eastern central Kansas, Sweeney estimated that 207,720,000 bbl of oil would be recovered by secondary recovery methods. The total productive acreage was 79,900, and the number of flooded and floodable acres was estimated to 38,000. The total cumulative production to January 1, 1948, was 600,657,000 bbl, of which the primary production was estimated to be 564,934,000 bbl, and the secondary recovery was estimated to be 35,723,000 bbl. The total water-flood reserve as of January 1, 1948, was estimated to be 171,997,000 bbl.

Look for
PAUL D. TORREY'S
article in the
REFERENCE ANNUAL
July 15, 1951
on specific techniques for improving the recovery of oil. It also has a good bibliography.

Illinois Projects

Water floods in southern Illinois, partly accidental, have been in operation since 1924. The initiation of systematic flooding projects was relatively recent, and the encouraging results indicated clearly the possibilities for improved methods of secondary recovery in producing horizons such as the Robinson, Kirkwood, and McCloskey.

A recent study[12] shows that 31 controlled water-flood operations were underway in Illinois as of January 1, 1950. The total flood oil from these and the many McCloskey dump floods up to this date was about 15,400,000 bbl. An average injection rate of 10 bbl per day per foot of sand was maintained for flooded sands averaging 20 ft in thickness. Other average reservoir statistics include: Porosity, 20 per cent; permeability, 150 millidarcys; fluid saturations at the start of flooding, 64 per cent oil, and 20 per cent water; ratio of water input to flood oil produced, 5 to 1 at the end of 1949.

As of January 1, 1950, the over-all recovery from the 8450 acres in the controlled floods was 1213 bbl per acre, which is encouraging when the early stage of development of many of the floods is considered. Recent information on 11 selected floods indicates an average secondary recovery of about 52,000 bbl of oil per acre in comparison to an average primary recovery of slightly over 3100 bbl per acre.[13] Yields of secondary recovery operations, which are expected to more than double those of primary recovery, indicate clearly the future importance of those projects to the future oil economy of Illinois, especially when it is considered that only a small part of the state's total oil-producing area of 376,000 acres has been affected by controlled water floods.[12]

The Patoka field in Illinois, discovered in 1937, is worthy of special mention because of the skillful engineering planning involved, which resulted in rather spectacular increases in production.[14] Water flooding was initiated in 1943. By August, 1946, 59 intake and 39 new producing wells were completed. The flooding pattern, in general, is a 10-acre 5-spot. A total of 62 intake wells and 40 oil wells were drilled. This number, combined with the number of wells from the original development, gives a total of 80 producers on 566 acres.[14] The cumulative water injected to March 1, 1950, was 16,300,000 bbl; cumulative water-flood oil produced was 5,451,000 bbl; and cumulative water produced was about 8,200,000 bbl. The ratio of cumulative water injected to cumlative oil produced of 2.9 is unusually good.[14] From estimates, the natural production from this field would have been 2,800,000 bbl, or 4950 bbl per acre. The cumulative water-flood oil recovery as of March 1, 1950, was 5,451,000 bbl or 10,250 bbl per acre. The ultimate oil recovery was estimated to be 9,200,000 bbl or 17,100 bbl per acre, of which 12,150 bbl per acre are associated with water-flooding. Much of the coring and planning in this field was done during its primary history. Operating costs per barrel have been kept low because of the exceptionally high recovery. Present plans include the installation of flowing equipment when the production rate will have decreased to 300 bbl daily.

The Salem unit, the largest water flood reserve in Illinois, and, with the exception of Bradford, the largest in the industry to date, is expected to be under operation shortly.[32] It has been estimated that 1,680,000,000 bbl of water will be injected during the life

of the flood, that 607 wells will be utilized for input purposes, and that about 205,000,000 additional barrels of secondary oil will be recovered, over and above future primary reserves.

East Texas Salt Water Disposal System

Although chronologically, the injection of salt water into the Woodbine reservoir of the East Texas field was initiated at a date later than the first water flood of the usual concept, the techniques employed have been similar, and the results of this major operation have been of so far reaching consequences that first mention historically appears to be highly in order. The original objective in this field was the disposal underground of produced salt water, and the prevention of fresh-water contamination in the East Texas region. The injection program also served to maintain bottom hole pressure with a resulting increase indicated in ultimate recovery. Salt was first returned to the reservoir in June, 1938. The mechanics of this water-drive have been discussed at length by Morris,[15] and are so thoroughly understood that pressure production relationships can be predicted within reasonable limits of accuracy. It is estimated that the ultimate recovery of the field will be increased by more than 600,000,000 bbl of oil as a result of the large-scale program adopted for the return of produced salt water to the Woodbine reservoir.

Water floods of the more familiar type are found principally in the north-central part of Texas in Wichita, Archer, Young, Clay, Throckmorton, Shackelford, Callahan, and Brown counties.[16] The sands are numerous and lenticular and their correlation between fields is difficult. The most continuous and most easily identified sand is that known variously as the Gose, Swastika, Gunsight, or Regal, and is found in Archer and Young counties at depths ranging from 600 to 1200 ft. Other sands of North Texas include the Thomas or Upper Wilmot, Cisco of varying shallow depths, 1600 ft Cisco, Fry, Lower Cook, Stine, Upper Tannehill, and Hope. They average 2 to 30 ft in thickness. The zones subject to the most successful water-flooding have relatively high porosity and permeability. Using existing wells, uniform spacing arrangements are uncommon, and the projects are usually developed on an irregular five-spot pattern.

Two water-floods were begun in Texas in 1930, one in Brown County, and the other in Wichita County.[1] Although accidental water floods were observed in the Corsicana shallow field as far back as 1934, no systematic project has been attempted so far in that area.[16]

In 1935, the Texas Railroad Commission granted its first permit to inject water into an oil-bearing formation to The Texas Company.[16]

Burkburnett Project Successful

The first successful systematic project in Texas is credited to Peterson and McCarty, who initiated operations in the old Burkburnett field of Wichita County, in June, 1936.[16] Continuing operations to abandonment, over 1300 bbl of secondary oil will have been recovered per acre from the 360 and 560 ft sands, which heretofore have been under primary operations for about 19 years.

An outstanding and successful water-flooding project in North Texas is that of the Cable Oil Company on a 40-acre lease in the Prideaux field, in southeastern Archer County.[16] This flood was begun in October, 1940, and recovered about 59,000 bbl of oil over and above the primary production decline. On the basis of 35 productive acres, and an average sand thickness of 12 ft, this increased recovery amounted to 1685 bbl per productive acre, or 141 bbl per acre foot.[17] Prior recovery by primary and gas injection methods amounted to 3283 bbl per productive acre, or 270 bbl per acre foot. The Gunsight sand is found at an average depth of 685 ft, and has an estimated average porosity of 25 per cent, and an average permeability of 500 to 600 millidarcys. In this project, the flush production was obtained during the first 3 years after the flood was started. The increased revenue after the flood was started was more than sufficient to return all operating costs, and the original plant investment, within the first two years of operation.

Most of the water flooding projects in North Central Texas have been successful. Increased oil recoveries have been in the range of 500 to 2000 bbl per acre.[1] The number of failures is noteworthy, and have resulted from by-passing caused principally by improper completion of injection wells, or from the use of excessive injection pressures.

Three experimental floods are in operation in the West Texas area, and recent attempts have been made to apply water flooding to some of the fields of South Texas and the Panhandle.[1]

Reservoir pressures declined rapidly in the New Hope field in Franklin County, in Texas during primary operations, and by 1946, all wells were produced by pumping.[18] With the injection of water, the reservoir pressure was increased by 500 psi, and the average well capacity and field producing rate were tripled. In addition, 20 of the 28 wells in the field were restored to flowing production.

During the past decade approximately 1,400,000 bbl of oil has been recovered through flooding in the semi-depleted fields in the north-central part of Texas.[16]

Bartlesville Launched Oklahoma Projects

Unsystematic water-flooding was started in the Bartlesville sand in Nowata County, Oklahoma, in 1931. In 1934, the first systematic waterflood was developed, and the number of projects has increased continuously from 1935 to 1941, the total remaining fairly constant from the latter date up to the present time.[1] Most of the operations are to be found in the shallow Bartlesville sand areas of Washington, Nowata, and Rogers counties. Although many of the early projects were economic failures, which discouraged widespread adoption of flooding, several proved to be very successful.

About 16,000,000 bbl of oil were produced from the eastern portion of the Delaware-Childers field, exclusive of the water-flooded areas, since air and gas injection programs were started in 1925.[17] This production represents an estimated 57.4 per cent of the original recoverable oil, which reduced the average oil saturation to about 39.8 per cent. From the above estimated average oil saturation and estimated present saturation of the sand of 13 leases nearing their economic limit, the conclusion has been reached that air and gas injection could not be used profitably to reduce the average oil saturation below 35 per cent.

After water-flooding the average residual oil saturation has been for the express purpose of secondary recovery of oil. Approximately half of the input wells are used to inject water into porous limestone formations.

A successful project was begun in the Chatham field, Medina County in 1939, after Governor Bricker signed the bill legalizing water flooding in Ohio.[22] The Berea sand, extremely variable and stratified with shale breaks, is found at depths ranging from 230 to 420 ft. Core analysis show that porosity varies from 13 to 20 per cent, permeability from 0 to 365 millidarcies, and oil saturation from 20 to 45 per cent. The pool is a monoclinal accumulation covering approximately 3500 acres. The recovery per acre, up to 1948 has varied from 1000 to 12,000 bbl, with an average of 5000 to 6000 bbl. The flood-out time varies from 3 to 10 years, with an average

of 8 years. Thirteen separate water-flooding projects have been reported,[1] which indicate that other Berea sand fields may react favorably to this method.

Water-flooding in Kentucky, confined to shallow fields in the western part of the state, was initiated in 1942 in the Cane Run field.[1] Floods were begun in the Birk City and Haynesville fields in 1945. Cores from the Weir sand of the Paint Creek Uplift fields indicate its adaptability for water-flooding. It is believed that successful secondary recovery activity by water-flooding may take place in these fields in the future.

California Possibilities Large

The oil that is non-recoverable through ordinary production methods from California depleted or near-depleted fields has been estimated variously as between 20.5 billion and 26.6 billion barrels.[23] This represents almost four times the state's cumulative production.

Modifications of flooding practices experienced in other areas must be developed to insure profitable operations in California. Unusual difficulties encountered are associated with deep, irregular steeply dipping structures; complex faulted systems; thick, lenticular, and interbedded shales and argillaceous sands and sandstones; and low gravity and viscous crude oils.

Diversified land ownership, which is illustrated principally in townlot development, increases the difficulties of successful unitization, and indicates the need for proper and sufficient legislation to insure the protection necessary for water-flooding operations.

Of the 28 past and current secondary recovery or gas or oil storage projects in California, nine are reported still in operation.[24] It is estimated to be 25 per cent.[17] As of July 1, 1945, the average saturation of the Bartlesville sand underlying the most successful water flood in the field was calculated to be 31 per cent. The estimated oil production up to January 1, 1948, was 118,000 bbl, which reduced the average oil saturation to 29.6 per cent.

The Bartlesville sand of the Hogshooter field of east-central Washington County, Oklahoma, produced 7,566,000 bbl of oil up to January 1, 1944.[19] This production represented only 10.3 per cent of the original oil in place, and the average total residual oil was estimated to be 11,776 bbl per acre, with an oil saturation of 53.4 per cent. The economic recovery from water flooding was estimated, conservatively, to be 4,875,000 bbl of oil from 1394 acres, or 3500 bbl per acre; and 5,620,000 bbl of oil, or 2500 bbl per acre from a separate area of 2248 acres that could be recovered profitably with an increase in the price of crude oil of at least 45 cents a barrel.

The first systematic water-flooding operations in the Weber pool of Washington County were begun recently.[20] The sand flooded is the Bartlesville, with an effective sand thickness of 15 to 27.7 ft. The well pattern varies from irregular to five-spot. Although the projects are too recent to permit an estimate of ultimate water flooding recoveries, good results are indicated. One 80-acre project is reported to have produced more than 2100 bbl per acre.

Although water flooding in Oklahoma in the past has been confined mainly to shallow pools, it is anticipated that many of the deeper pools that have responded to vacuum or gas injection are excellent prospects for future water floods.[21] The famous Burbank field in Osage County is one example, which should supply interesting comparisons for the future.

An experimental five-spot water flooding operation was begun in the Cabin Creek field, Kanawho County, West Virginia, in 1937.[1] Although it is believed generally that the formations in this area lend themselves more readily to air and gas repressuring than to water flooding, the Cabin Creek project proved to be sufficiently successful as to encourage the initiation of other experimental floods.

In this same year, 1937, salt water produced with the oil was injected initially into porous underground formations in Michigan.[1] Except for the Greendale field, no record exists for the employment of water injection addition, there are eight active primary pressure control projects. Water flooding attempts, however, have been limited.

Richfield, Michigan, Project Is Success

The most notable flood is the experimental project in the Chapman zone of the Richfield field, found at a depth from 3000 to 3700 ft.[24] The productive portion consists of a large irregularly shaped sand over 400 ft thick at the top of the structure. The sand is replaced gradually by intruding shale members that predominate toward the edge of the reservoir.[23] The sand consists of poorly sorted grains of medium size, friable and argillaceous, with a porosity varying from 29.1 to 31 per cent; permeability to air varying from 422 to 1100 millidarcies, and an estimated average interstitial water content of 37 per cent. The gravity of the oil varies from 16 to 22 deg API, and its viscosity is approximately 50 centipoises at a reservoir temperature of 160 F.[24]

The oil recovered up to 1945 was estimated to be about 19 per cent, while the ultimate recovery by normal depletion methods was estimated to be close to 21 per cent of the original oil place.

A total of 326,900 bbl of water had been injected into the formation

New Degree of Engineering Geologist Given

The first professional degree of engineering geologist ever awarded was conferred at Louisiana State University June 2nd to Alvin James Bourgeois of Baton Rouge. A new curriculum, established just two years ago at the request of oil companies, has made Bourgeois a jack of all trades in the petroleum industry; a specialist in some phases and a speaking acquaintance with all.

To receive the degree he was required to be a top ranking student in chemical engineering for his last two undergraduate years (he held a 2.7 average; 3 is perfect); for two graduate years, plus summers, he majored in geology; and along the way he has made side trips into chemistry, electronic physics, mechanical engineering and soils mechanics.

Dr. Richard J. Russell, graduate school dean and geologist, set up the curriculum with the advice and encouragement of petroleum industry executives interested in all-round training.

"Companies today are highly departmentalized, with experts in each division—but few people speak the language of them all," Dean Russell points out. "Men are needed who are familiar with all fields, to coordinate and develop over-all policy."

Bourgeois' job with the Shell Oil Company in Houston will start in the geophysics department. After thorough orientation, he will eventually go into the interdepartmental liaison work for which he was trained.

by the end of 1947 through one injection well at the rate of about 300 bbl daily, and at an injection pressure of 700 psi. One well, 900 ft from the injection well, and three others at less distance, were affected by flooding. Although the total daily production increased from 58 bbl at the beginning of the flood to 198 bbl in the latter part of 1947, the financial success of the venture was not demonstrated.

As a disposal project, salt water was injected, at a rate of 2400 bbl daily and at a pressure of 2500 psi into the Stevens zone of the Greeley field in 1944. This zone is found at a depth of 7700 ft. The production from an adjacent well increased from 150 to 300 bbl daily, giving tentative evidence of the benefits of primary pressure control through water injection.

Although other projects in California have not been as successful, additional large scale operations such as those of the Dominguez and the Lost Hills field have been planned and presumably are under way at this time.[1 23]

Arkansas Secondary Reserves

Recent studies by Fancher and Mackay[1 25] indicate that the secondary reserves of Arkansas are almost equal to the existing primary reserves. Although secondary recovery methods have not found general acceptance in the older fields of the state, the more recent Wesson-Hogg Sand field of Ouachita County shows very satisfactory increases in recovery as a result of water-flooding. The areal extent of this field is approximately 1500 acres. The producing reservoir, a narrow sand bar, is cut off by a fault at one end, and is bounded by edge-water at the other end. The sand has an average thickness of 24 ft, is highly porous and permeable, and will, therefore, require only a minimum number of injection wells for successful flooding. Because of the low bubble-point oil, reservoir pressures have dropped rapidly with cumulative production.

The field was unitized on July 1, 1948, and flooding operations initiated. The reservoir pressure has increased since injection started, and is expected to continue increasing until the wells flow their production. As a result of this program it is estimated that 18,775,000 bbl of additional oil will be recovered, or, an increased recovery due to water - flooding of 1250 bbl per acre. This is 165 per cent of the recovery expected from primary production methods.

Effective pressure - maintenance projects are underway in the Midway, Magnolia, and Schuler field at considerable depths from Lower Cretaceous and Jurassic formations. Later projects have been initiated in the Atlanta and Haynesville fields.[25]

The results obtained in the Midway field are of particular interest in that water was injected beneficially into a porous limestone. The field has a productive area of 1800 acres. About 191,000,000 bbl of stocktank oil were estimated to be in place originally.[25] Of this amount, 5 per cent had been produced to the end of June, 1946. Although there is direct evidence of a natural water drive, the field is bounded on all sides by barriers that have been considered in the prediction of pressures and reservoir behavior. A total volume of 350,000 bbl of water was injected into the Smackover limestone reservoir up to September 23, 1943. An average volume of 2200 bbl daily was injected in the first well against an estimated pressure of 620 psi. Three additional injection wells have been completed, and, as a result of the operation, reservoir pressures have been maintained above bubble point, and have actually increased with increased rates of oil withdrawals. Both produced salt water and fresh water have been injected into the reservoir with no detrimental plugging effects. At least 8000 bbl of water daily are required to supplement the natural influx of water and make up for the withdrawal of reservoir fluids and shrinkage. The constant rate of production, gas-oil ratio, and gas richness facilitate gasoline plant operations. In addition, the requirements for artificial lifting of oil have been reduced.[16] It has been estimated that oil recovery from the field will increase some 35,000,000 bbl by the water-injection operation. This increased production is double the amount estimated for primary production methods.

Pressure maintenance by gas injection in a sand reservoir of the Schuler field, Union County, Arkansas, resulted in a leveling of pressure equal to that existing before injection began.[18] The subsequent injection of water caused the pressures to rise with a resulting productive capacity well above the allowable rate of 9000 bbl daily.

Prospects in Indiana

Two water-flooding projects have been under way in Indiana for a limited period.[1] These are the Ribeyre Island area of the New Harmony field in Posey County, and the North Owensville field of Gibson County. Positive increases in production have not been established as yet, but geologic conditions are believed to be favorable for secondary recovery operations in many of the shallow fields of southwestern Indiana.

Several flooding operations have been attempted in the Bellevue field, Bossier Parish, Louisiana, with inconclusive results.[1] An interesting and important project is recorded for the Upper Pettit zone of the Haynesville field in Claiborne Parish 48 miles northeast of Shreveport.[27] The field lies in both Louisiana and Arkansas. This limestone reservoir was discovered in November, 1941. It has an average depth of 5250 ft, an average pay thickness of 11 ft, an average porosity of 20 per cent, and an average permeability of 20 millidarcies. Following gas injection, at a reservoir pressure of 1400 psi in 1945, an experimental water - flood was initiated the ensuing year. By December of 1948, it was anticipated that 1,300,000 bbl of additional oil would be produced by water-flooding, and would continue at the rate of 2200 bbl daily. The application of water-flooding of this type to limestone reservoirs is considered to be of considerable influence to recovery technology in other important producing areas.

The performance of the Miller Three Zone Unit in the West Tepetate field, Louisiana, at a depth of 8500 ft, is an outstanding example of the benefits that can be obtained at greater depths.[18] It was estimated that 3,700,000 bbl would be recovered by natural depletion. Gas and water were injected into the reservoir, and by mid-1949, a greater amount of oil was produced than that estimated for primary operations. The rate of production was maintained at 75 per cent of its peak.

Injection in Salt Dome

An unusual experiment was reported some years ago[28] for the East Hackberry field in Cameron Parish, southwest Louisiana. Oil production was first discovered on this piercement-type salt dome in 1927. The main Camerina sand reservoir of Oligocene age is located on the south flank of the dome and dips away from the salt at a sharp angle. This reservoir has a total length of about 3100 ft, and is provided with 10 producing wells. Salt water injection was initiated in 1945, and the project has been reported to be performing satisfactorily, although subsequent production has not been made available.

The experimental injection of water into the Upper Cretaceous sands of the Salt Creek field, Wyoming, is the most important water-flooding project known for the Rocky Mountain areas. An experimental water-flood is also in operation in the Shannon sand of the Cole Creek field.[1]

Although no water-flooding proj-

ects have been attempted in New Mexico up to this time, the New Mexico Oil Conservation Commission has given two major oil companies permission recently to initiate secondary recovery operations by the injection of water into wells located in the Penrose-Skelly Pool in Lee County.[25]

Conclusion

From the inception of water-flooding in Pennsylvania in 1907, expansion of this practice has proceeded state by state in the chronological order in which the states have been discussed. In each state, flooding operations have progressed from shallow to greater depths and has led to the injection of water in new reservoirs for the purpose of pressure maintenance and the increase of recoverable oil.[29]

Whereas New York and Pennsylvania were the only states provided with laws permitting and regulating secondary recovery practices over 20 years ago, at the present time unitization laws have been enacted and nineteen states have at least some type of regulation.

Greatly improved methods of recovery have occurred since the initial efforts at Bradford, which have insured the success of otherwise unprofitable or marginal projects. Advanced research techniques have been developed, but many problems in the theoretical aspects of secondary recovery remain unsolved.[30]

The pioneer research program of the Pennsylvania Grade Crude Oil Association and the Pennsylvania State College mentioned earlier in this paper, has been augmented and accelerated by numerous oil companies and agencies such as the United States Bureau of Mines, the American Petroleum Institute Standing Subcommittee on Secondary Recovery Methods, the Secondary Recovery Committee of the Independent Petroleum Association of America, the Interstate Oil Compact Committee on Secondary Recovery, the Texas Petroleum Research Committee, and many other state oil and gas divisions, geological surveys, and district oil and gas associations.

At the end of 1947 Torrey[1] estimated a secondary oil reserve of 7,156,700,000 bbl in the United States. This figure is considered to be a first approximation and will be revised from time to time when the results of special studies such as those made by the Interstate Oil Compact Commission become available. It appears probable that the oil physically recoverable by secondary means will be materially greater than this preliminary estimate. The reserve directly attributable to water-flooding and to pressure maintenance induced by water injection undoubtedly will be designated separately from other classifications.

API Committees Study Standardization Problems

The American Petroleum Institute Committee on Standardization of various segments of oil field equipment met in Denver, Colorado, recently, in connection with the Division of Production's mid-year meeting.

Difficulties encountered in holding extremely high pressures found in deep wells were considered by the committee on standardization of oil country tubular goods. These high pressures have caused numerous failures of casing and tubing, particularly in the threaded connections. The committee has taken steps to test casing and tubing at the mills to 80 per cent of the yield strength, which approximates the pressure encountered in service. Millon Institute has been authorized to develop a joint compound that will both lubricate the connections and seal the connection against leakage at high service pressures and temperatures.

In another approach to solving the problem, the committee has developed procedures for joint make-up in the field, which prove that API casing and tubing connections, when properly made up with suitable compounds, will maintain pressures currently encountered.

The committee on standardization of derricks and masts discussed the need to standardize design features. Because of its expanded use, the committee has given special consideration to standardization of mast design and construction, as well as to the types of steel that are adaptable to construction. A specification covering guyed portable masts has already been developed, and the refinements necessary to complete standardization for the industry are now being weighed by the committee.

Many recommendations that will increase the service life and provide for more economical operation were made by the API committee on standardization of wire rope for oil field service. Because of the contemplated shortage of critical materials, proper care of wire rope was emphasized.

Bibliography

1. Torrey, Paul D., Secondary Recovery of Oil in the United States, American Petroleum Institute, 1950.
2. Bauer, G. Gerald, Secondary Recovery and Natural Gasoline Industry are Developments of Bradford Field, The Producers Monthly, November, 1946.
3. May, D. T., History of Water Flood Development, Producers Monthly, November, 1946.
4. Fancher, George H., Theoretical Considerations Involved in Secondary-Recovery Operations, Secondary Recovery of Oil in the United States, American Petroleum Institute, 1950.
5. Buckwalter, John, How Much More Oil Will Bradford Produce?—Producers Monthly, October, 1948.
6. Horner, William L., Control and Prediction of Secondary Recovery, Secondary Recovery of Oil in the United States, American Petroleum Institute, 1950.
7. Bauer, G. Gerald, Developments in Pennsylvania Grade Secondary Recovery Research, Producers Monthly, August, 1948.
8. Jewett, John Mark, Sub-surface Aspects in Kansas Water-Flooding, World Oil, December, 1948.
9. Joers, John C., et al, Water-Flooding in the Humboldt-Chanute Oil Field, Neosho and Allen Counties, Kansas, Producers Monthly, June, 1950.
10. McCaslin, L. W., Jr., Eastern Kansas Water Flood Increases Production, The Oil and Gas Journal, February 26, 1948.
11. Sweeney, Albert E., Jr., Summary of Secondary Recovery, Production Statistics and Estimated Water-Flood Reserves, Kansas, 1948; also Summary of Secondary Recovery Projects: Kansas, 1950; Joint surveys, State of Kansas and the Interstate Oil Compact Commission, September 1, 1949, and January 1, 1950.
12. State of Illinois and the Interstate Oil Compact Commission, Summary—Water Flooding Operations in Illinois, 1950.
13. Torrey, Paul D., Economic Significance of Secondary Recovery Operations and Reserves in the Eastern States, Producers Monthly, September, 1950.
14. Sweeney, Albert E., Jr., Recovery Practices in Other States Applicable to West Virginia, Conference on Secondary Recovery of Oil in West Virginia, West Virginia Geological Survey, Morgantown, West Virginia, October, 1950.
15. Morris, W. S., Results of Water Injection in Woodbine Reservoir of the East Texas Field, Secondary Recovery of Oil in the United States, American Petroleum Institute, 1950.
16. Gibbon, Anthony, North Texas Water-Flooding Possibilities, The Oil Weekly, October 28, 1946.
17. Krog, Walter C., Economics of Water Flooding in North Texas, World Oil, April, 1945.
18. Evans, R. L., and Roe, R. P., Increased Oil Recovery from Injection Operations, The Oil and Gas Journal, September 28, 1950.
19. Fox, I. W., et al, Water-Flood Possibilities in the Hogshooter Field, The Oil Weekly, May 14, 1945.
20. Johnston, Kenneth H., and West, James A., Water Flooding in Weber Pool, December 15, 1950.
21. Heath, W. A., and Betzer, S. I., Secondary Recovery in Oklahoma, Secondary Recovery of Oil in the United States, American Petroleum Institute, 1950.
22. Cashell, Jack R., Secondary Recovery of Oil in Ohio, Producers Monthly, June, 1948.
23. Somerton, W. H., California Water-Flooding Practice and Research, World Oil, October, 1949.
24. Sneddon, Richard, Secondary Recovery in California, The Petroleum Engineer, September, 1945.
25. Fancher, George H., and Mackay, Donald K., Secondary Recovery of Petroleum in Arkansas—A Survey, Arkansas Oil and Gas Commission, El Dorado, Arkansas, 1946.
26. Compact Comments. Interstate Oil Compact Commission, January, 1951.
27. Vitter, A. L., and Phillips, J. C., Secondary Recovery in Louisiana, Secondary Recovery of Oil in the United States, American Petroleum Institute, 1950.
28. Euwer, M. L., Salt-Water Injection for Pressure-Maintenance in East Hackberry Field, Louisiana, The Oil and Gas Journal, September 19, 1945.
29. Heath, W. A., Twenty Years' Progress in Secondary Recovery, Independent Association of America Monthly, September, 1949.
30. Power, Harry H., Significant Research in Petroleum Recovery, The Petroleum Engineer, February-March, 1950.
31. Barger, H. S., and Campbell, J. H., Water Flooding in Illinois, St. Louis Meeting, A.I.M.M.E., February, 1951
32. Love, Richard W., The General Aspects, Engineering and Operational, of the Formation of the Salem Unit, St. Louis Meeting, A.I.M.M.E., February, 1951.
33. Barnes, Kenneth B., Orderly Water-Flood Program for Mid-Burbank Unit, Osage County, Oklahoma, Oil and Gas Journal, March 15, 1951

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Techniques Multiply Reserves

In recent years the most important development in maintaining petroleum supply comes from improved methods of recovery, both primary and secondary. Water-flooding, gas repressuring, and, recently, applications of chemicals have proved again that technical knowledge multiplies reserves. Old fields are revived by injections of water, gases under high pressure, combined water and gas, and carbon dioxide gas in water flooding. When pressure maintenance is used in the early life of a field, recovery is greatly increased. Acidizing and the new Hydrafrac treatment have made it possible to produce individual wells that in earlier days would have been dry and abandoned.

At a time when demand is high and materials are scarce this growing efficiency in recovery is an invaluable contribution of the oil industry to our economy. Costs and materials in flooding and repressuring projects are much less than those required to find and develop a new field. The vital ingredients for successful recovery projects are knowledge of subsurface conditions to evaluate the possibilities of greater production and engineering know-how to carry out the operations. These we are gaining with accelerating speed. The Oil Recovery Conference held in April at Texas A. & M. College added substantially to the literature on producing efficiency. The huge expenditures in research made by oil companies are paying off in producing once non-recoverable petroleum.

In the Kelley-Snyder and Scurry County area, considered one field by the Texas Railroad Commission, reserves are estimated at one billion barrels if produced by conventional methods. Under a plan of pressure maintenance in which 30 companies and some 60 individuals will cooperate, it is estimated actual production can be double that volume, or two billion barrels. The cost of developing this added reserve will be about 15 per cent of the average cost of discovering and developing new fields.

In the once-abandoned Osage field in Oklahoma a huge water-flooding project is expected to produce as much oil again as was produced by natural energy when the fields were first found.

So here we have two projects, one in a recently discovered field and one in an old depleted field, where supply is virtually doubled by improved producing techniques.

Even these new and efficient projects will not be able to recover all the oil in the sands; but with the strides being made by the researchers and the petroleum engineers, the time will come when the percentage recovery of the original oil in a reservoir will be vastly greater than at present. Estimated reserves have already become a relative figure. Not only is oil where you find it. Oil is where you can produce it.—E. A.

"KEEP IT CLEAN"

Just *choose the type* BAKER CASING SCRAPER your job requires

If you have ever tried to run a swab and had the rubber cups so badly torn and damaged that they were useless – if you have ever hit a spot through which a packer or cement retainer would *not* run and had the slips set prematurely – you already *know* that the inside walls of casing should be scraped clean.

There is no longer need to have imbedded bullets, burrs from gun-shot holes, a hardened cement sheath, or any other obstructions, cause you trouble. Anything that projects from, or adheres to the important "working surface" of casing – even down to mill scale or rotary mud – can be quickly, easily, safely and economically removed from the inside wall of the casing. And this vital work of scraping can be done either while the rotary rig still is up and you are drilling out the cement shoe; or at any convenient time by running the scraper on tubing or a wire line for vertical removal of obstructions.

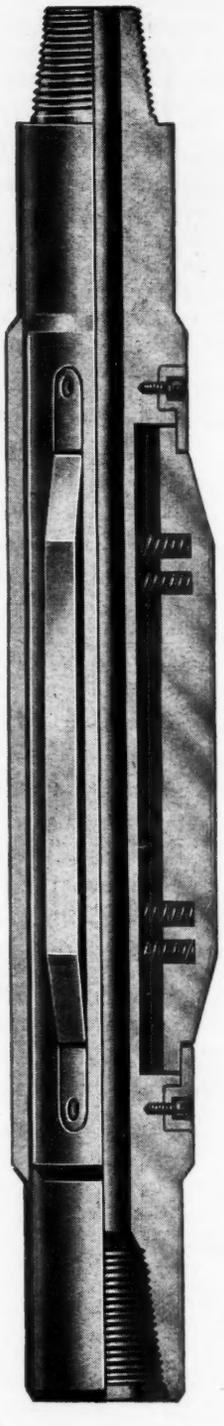
TWO TYPES OF BAKER CASING SCRAPERS MEET EVERY REQUIREMENT

The field-tested Baker MODEL "B" Casing Scraper (Product No. 620-B) is recommended for use when the rotary rig still is up and only hardened cement or a limited number of gun-shot burrs are to be removed. It is usually run just above the bit while drilling out cement, and will remove protruding burrs as well as the thin sheath of cement left even after the maximum gauge bit has been used for drilling out.

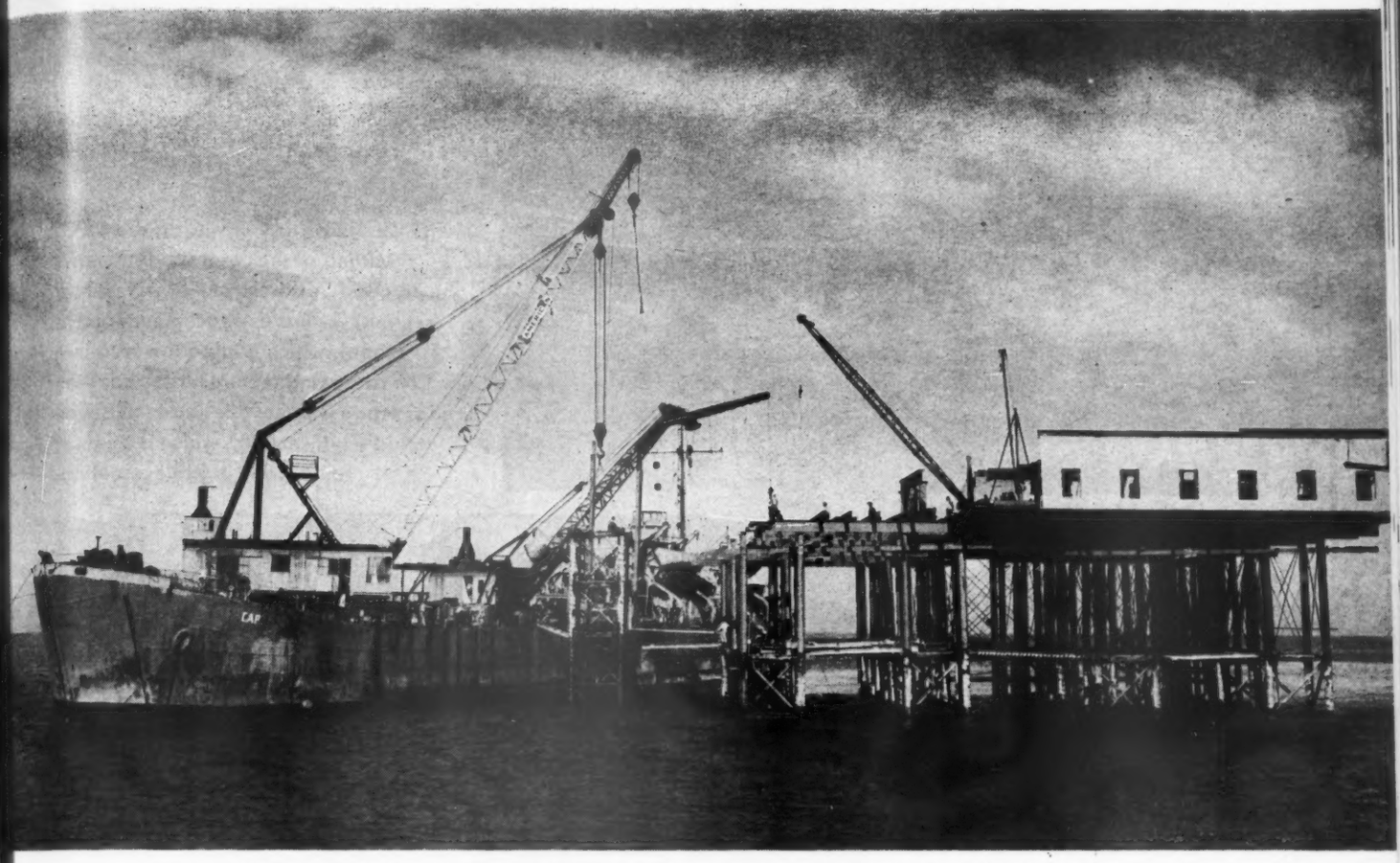
When there are several hundred gun-shot holes (with possible imbedded bullets); or if the hardened sheath of mud is to be removed from top to bottom of the well, the new Baker ROTO-VERT Casing Scraper (Product No. 620-C) is recommended. The ROTO-VERT can be run on drill pipe for successful vertical scraping of obstructions as it is being lowered in the hole, followed by rotation if difficult well conditions make rotation necessary or desirable; or it is run on tubing or a wire line for successful all-vertical scraping.

SCRAPING IS A VITAL PART OF WELL COMPLETION

Many operators consider that the use of a Baker Casing Scraper is a "must" in the completion of *every* new well, and after *every* gun-perforating job. They *know* that the inside wall of the casing is left smooth and "clean as a hound's tooth" ready to run a swab or testing



Baker MODEL "B" Casing Scraper
Product No. 620-B



Here is an oil drilling platform in process of construction in the Gulf of Mexico. Imagine what a sudden increase in wind from a squall could do to this peaceful construction scene, if adequate warning were not received.

Weather Radar and Offshore Operations

The new electronic tool in the hands of meteorologists gives greater safety from squalls and storms in overwater drilling

W. W. HILDRETH, JR.*

WIND and waves have always been of concern to those engaged in marine work. A relatively small increase in wind speed generates waves that cause inefficiency or possibly danger in small boat operations. For instance, at an unprotected location in a half hour, a 20-mile per hour wind will result in a 2-ft wave; a 30-mile per hour wind, a 3-ft wave, and a 50-mile per hour wind, a 5-ft wave. If the wind is of longer duration, the waves continue to increase and after 3 hours, the 20-mile per hour wind has produced a 4-ft wave; the 30-mile per hour wind, a 7-ft wave; and the 50-mile per hour wind, a 15-ft wave.

Winds up to 30 miles per hour are frequent in the day to day march of high and low pressure areas, with winds of 30 miles per hour or more in tropical storms and 75 miles per hour or more in hurricanes. All these weather phenomena are large-scale atmospheric disturbances whose characteristics and movements are relatively easy to predict 12 to 48 hours in advance. In contrast to these are the small-scale disturbances such as thunderstorms, line squalls, or tropical squalls that can produce strong, gusty, and sometimes shifting winds in a matter of minutes. Although the probability of the formation of the small-scale disturbances over a given area can be forecast, their exact location, movement, and characteristics were at a time difficult to forecast accurately until the latter years of World War 2 when a new tool, an electronic device called radar, was made available to the meteorologist.

EXCLUSIVE

In connection with meteorological services provided offshore oil operators on the Louisiana coast by A. H. Glenn & Associates, the author had the opportunity of utilizing two radar sets, an SCR-784 10 centimeter modified war surplus radar (Figs. 1 and 2) and a CR-101 3 centimeter radar located at Grand Isle, Louisiana, on routine schedule during the period June 1948 to June 1950. These sets were indispensable in observing and

*A. H. Glenn and Associates, New Orleans.

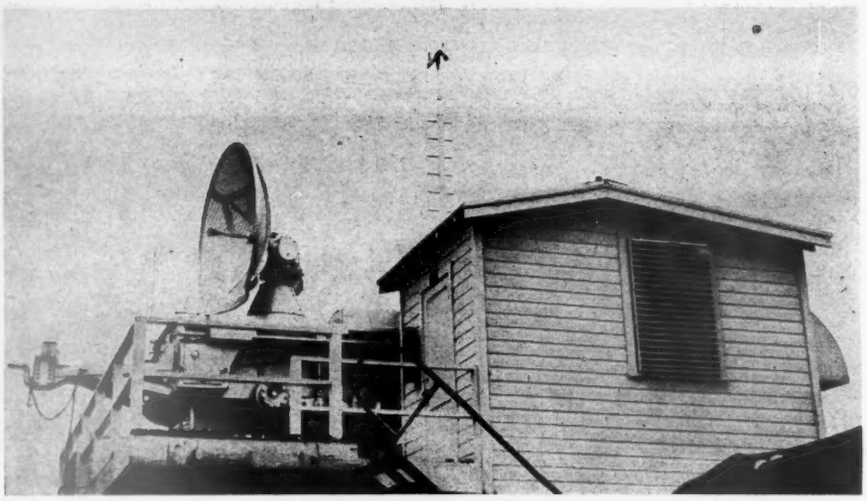


FIG. 1. Above, exterior view of modified war surplus SCR-784 10 cm radar at Grand Isle, Louisiana, used for locating and tracking weather phenomena. Pulse rate is 180 pulses per second, which gives it a theoretical range of approximately 500 miles. Pulse duration is 2 microseconds. The antenna with its parabolic reflector rests on the housing for the receiver, transmitter, and other electronic equipment. Operating building at left encloses the end of the trailer containing the control panel and viewing screen (scope). The building also serves as a weather office. One end contains a standby generator and has a dark room for developing pictures.

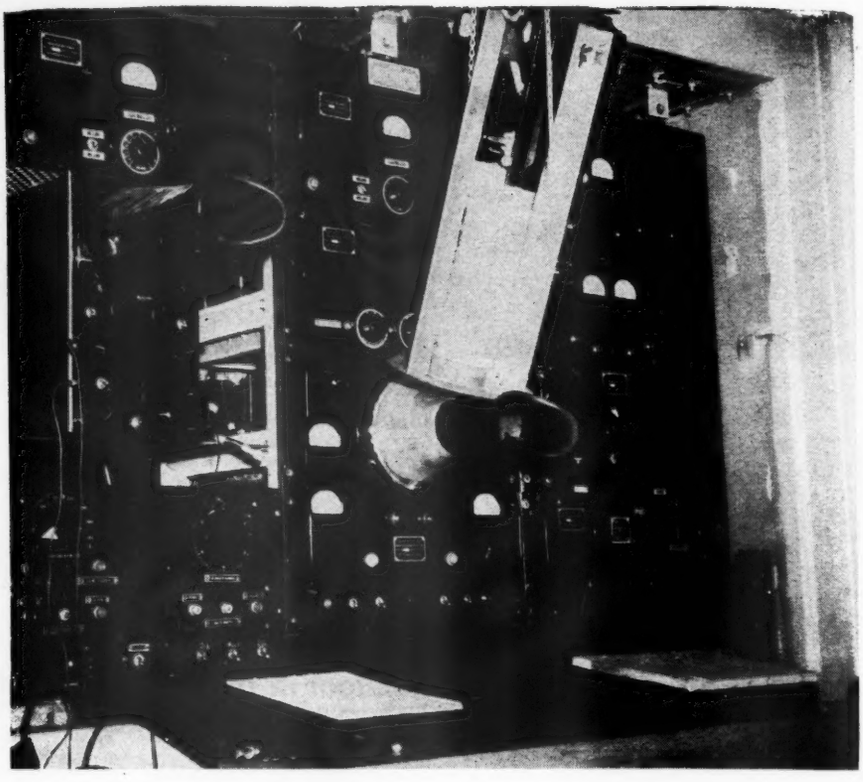


FIG. 2. Below, a view inside the radar building of the control panel shows the hooded radar scope (lower center section), camera attachment (above scope), which can be lowered into position for taking pictures after hood on radar scope is removed, and oscilliscope (middle left section), which is used for tuning and trouble shooting.

forecasting localized weather and resulting localized wave conditions, and proved particularly valuable in conducting research on weather processes on the Gulf Coast with the ultimate result of improving accuracy of 24 to 48-hour forecasting. In discussing the application of weather radar in offshore operation with personnel of the companies operating offshore, it has been evident that considerable confusion exists as to the value of the instrument. Opinions range from blind conviction that weather on the Gulf Coast cannot be predicted to an extravagant dream that radar is the answer to all weather problems. In the hope of clarifying opinion this paper explains briefly the principles of radar, why it can be used in weather forecasting and research, and its application in forecasting weather and wave conditions for offshore operators.

The word radar is derived from the phrase *Ra*dio *D*etection *A*nd *Rang*ing, connoting that radar makes use of radio waves to detect and locate objects. In addition to determining the ranges or distance, the radar can also indicate the azimuth toward which an object lies.

A radar set includes a special radio transmitter; an antenna with a parabolic reflector used both in transmitting and receiving; a special receiver; and an indicator. The transmitter produces energy in the form of short bursts or pulses of radio waves, which the antenna sends out into space concentrated in a narrow beam, analogous to a searchlight beam. The antenna is rotated and the beam of radio waves sweeps over the territory around the set. Objects that lie in the path of the beam reflect some of the energy back to the radar set and this reflected energy is picked up by the antenna and sent to the receiver, which is tuned to pick up these reflected energy signals. The receiver amplifies and passes the signals through special electronic circuits to a scope somewhat comparable to a television screen, thus creating a display showing the location of objects around the radar set.

The manner in which the radio waves from a radar determine distance is similar to the manner of determining the distance to a cliff by shouting and then recording the time it takes for the echo to return. In this case, the speed of sound is known and the distance to the cliff can then be determined. In radar the time taken by a pulse of radio waves to travel to the object, be reflected and return is determined, and knowing the speed of the radio waves, the distance to the object can be ascertained.

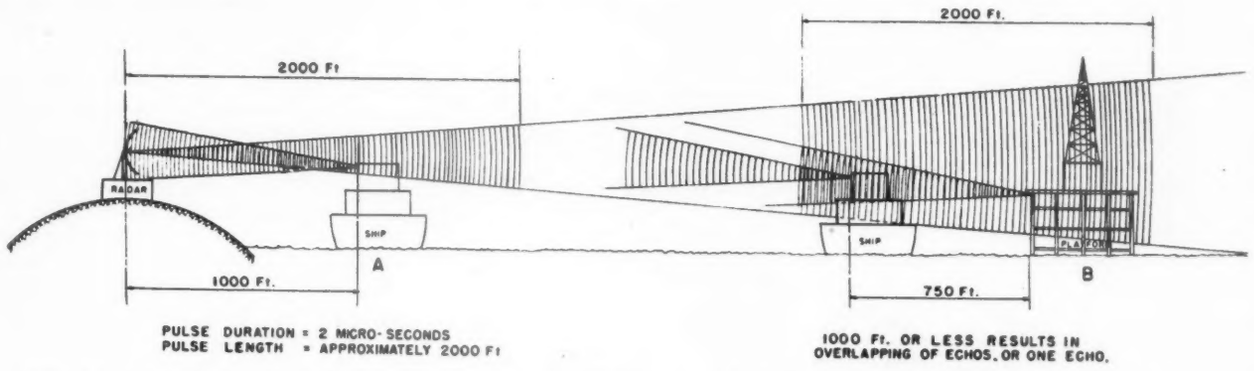


FIG. 3A. Sketch showing pulses of radio energy moving through space and being reflected by selected points that are, in case of ship A, too close to de detected and, in case of ship B and platform, too close to be resolved into separate echoes because of the long pulse length.

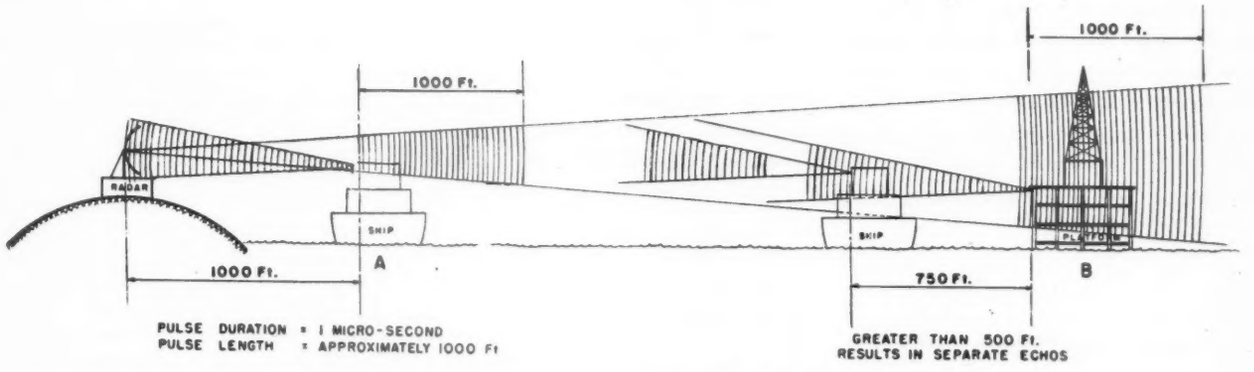


FIG. 3B. In this sketch a shorter pulse length is used and ship A is detected and ship and platform B are resolved into separate echoes. Comparing Figures 3A and 3B, notice that the minimum distance for an object to be detected, or for more than one object to be resolved into separate echoes, is one-half a pulse length.

Radio waves travel with the speed of light, which is fairly constant at 186,300 miles per hour. Expressed more conveniently for radar work, radio waves travel .1863 miles in a micro-second (1/1,000,000 of a second) or in 5.374 micro-seconds travel a mile. To detect an object one mile from the antenna, it takes 10.75 micro-seconds; 5.374 to reach the object and 5.374 to return to the antenna. This is the round trip time for an object one mile distant. A distance of 492 ft corresponds to a round trip time of approximately one micro-second, although for practical purposes 500 ft is sufficiently accurate and easier to remember.

After the radar emits a pulse of radio waves and an echo of radio waves is returned, the electronic circuits translate the echo received into a spot of light on the scope representative of the distance from the radar and with the same azimuth as that of the object causing the echo. This provides the operator viewing the scope with a picture of the location of the object.

As the antenna is used both for transmission of energy and for the reception of their echoes, transmission must terminate before reception can begin. Therefore, short pulses of energy are desirable not only to detect objects close to the antenna, but also to insure better separation or resolution of objects in the path of the beam of energy. For a pulse duration of two micro-seconds, objects must be approximately 1000 ft apart or 1000 ft from the antenna in order to be detected, while for a duration of one micro-second objects would have to be 500 ft apart or 500 ft from the antenna to be detected, as shown in Fig. 3.

As radar antennae rotate to scan surrounding objects, it is desirable to send many pulses per second in order to secure a complete coverage and maximum return. Most radar sets send out several hundred pulses per second.

For attaining maximum accurate detection distance, other factors remaining the same, the interval between pulses is a major factor, for the longer the interval the greater the distance from which echoes can be received before the next pulse of energy is transmitted. Echoes received from the first pulse, after the second pulse has been sent, give erroneous distance indication. A radar set designed to detect objects within a distance of 100 miles must have an echo time of at least 100 by 10.75 or 1075 micro-seconds This requires a pulse rate of less than 1,000,000/1075, or 930 pulses per second. The rate for a 500-mile range is ⅕ as much, or 186 pulses per second.

Of course, in speaking of maximum distance of a radar, we are referring to distance into space. For detection on the earth's surface, curvature of the earth must be taken into account. The maximum distance then depends mainly on the height of the radar antenna above the surface. Other factors determining maximum distance are the size of the antenna, power output, receiver sensibility and weather conditions.

Another factor affecting both distance and detection, especially in weather work, is the radio wave length.

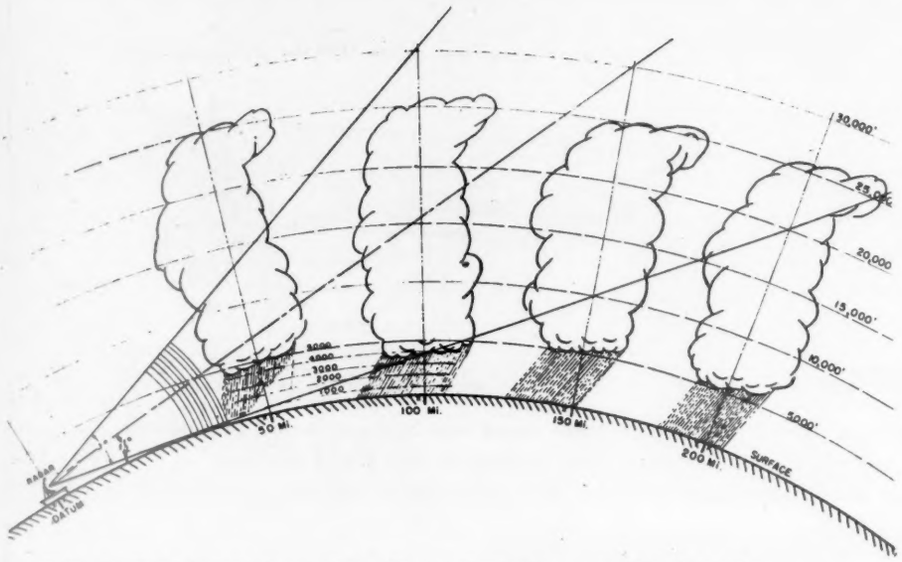


FIG. 4. This sketch shows the effect of curvature on the detection distances of the radar and the amount of cloud intercepted by the beam. The Grand Isle radar has been modified from a 4° to a 3° beam. The beam is usually elevated from 0-3° in order to achieve the maximum echo return and it is necessary to make this adjustment with each observation. The lower edge of the beam indicates the height required for an object to be detected at increasing distances from the radar.

The longer the radio wave length, the greater the distance that the wave can be transmitted without loss of power. But for long wave lengths only large dense objects will cause echoes strong enough to be detected. With shorter wave lengths detection of small objects improves, but the range attained is less, because of greater loss of power due to attenuation and dispersion of the radio waves by the atmosphere.

Radar and Weather Observation

Thus far the actual use of radar in weather observation has not been mentioned. It was discovered during World War 2 that raindrops reflect the radio waves back to the radar just as do ships, airplanes, and other material objects. The radar will therefore locate accurately cloud formations in which raindrops exist.

Radar for weather observation must meet a few special requirements. In particular, the wave length must be a compromise between too long a wave that would pass through all the drops without being reflected, and too short a wave which would be badly attenuated by precipitation near the set. On the Gulf Coast where heavy tropical rain areas are to be detected, the 10 cm wave length has proved superior.

Another requirement for weather radar is a suitable beam width. Remembering the comparison between the radar beam and the searchlight beam, it is evident that a wide beam covers more area but is less accurate in determining direction, has poor resolution, has less power per unit area, and, therefore, is not good for long range work. For weather application a narrow beam with great penetrating power for accuracy and distance is necessary. To provide a narrow beam a large parabolic reflector for the antenna is required.

The radar beam, like the searchlight beam, travels in a more or less straight line except for atmospheric refraction that depends on the temperature and humidity gradient in the atmosphere. As the beam normally travels with only a slight curvature, the earth falls away rapidly from under the beam even when the elevation is negligible, as shown in Fig. 4. The height to which an object must extend in order to be detected can also be determined from Fig. 4. Therefore, the limiting distance, at which precipitation areas can be detected, depends on the vertical development of the clouds and their rain or snow content. Those rain cloud formations associated with tropical squalls and thunderstorms generally have the greatest vertical development of any observed on the Gulf Coast and sometimes reach heights of 30,000 to 40,000 ft. Theoretically these should be detected at distances of 250 to 300 miles with the proper wave length and power. The moisture content of these clouds, however, apparently is too sparse above 20,000 ft to cause appreciable returns in the 10 cm band, and therefore precipita-

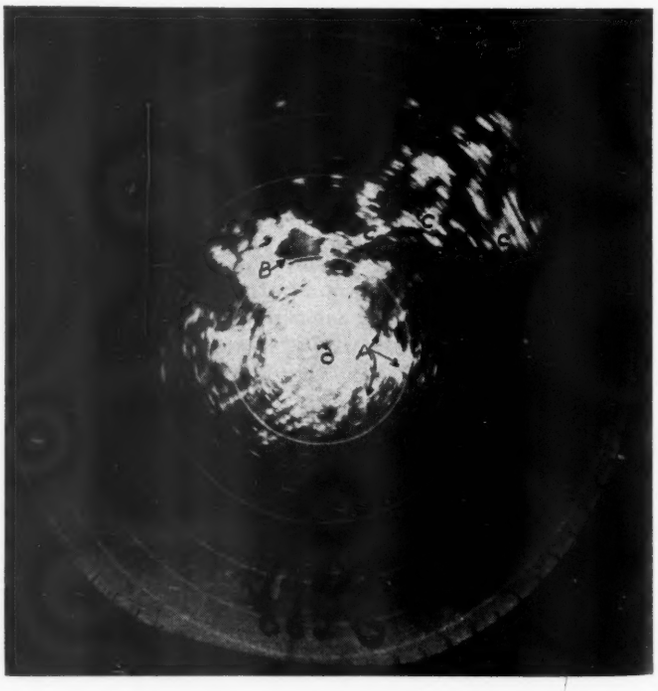
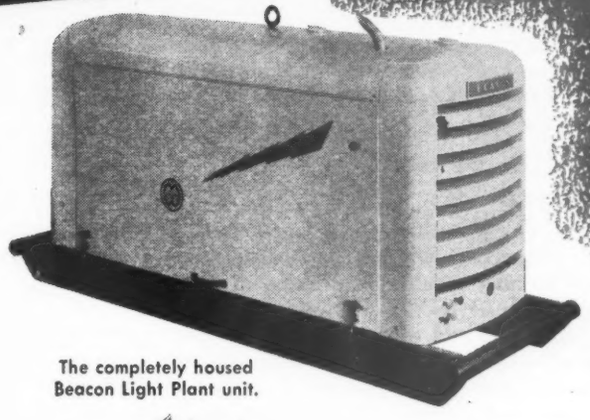


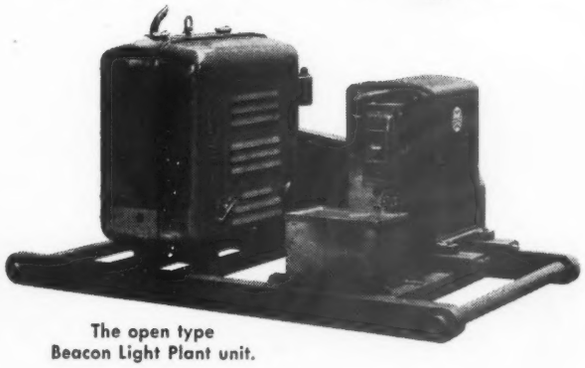
FIG. 5. Radar scope photograph, showing abnormally great detection distances, caused by the anomalous propagation of radar energy when trapped in an atmospheric duct close to the earth's surface. Irregular white areas are the result of echoes received from objects on the earth's surface, i.e., land, trees, buildings, rigs, bridges, ships, platforms, etc. The center point (O) indicates the location of the radar at Grand Isle. Each concentric ring indicates another 50-mile distance from O. N indicates North; E indicates East. Time is Central Standard. Notice the outline of the Mississippi Delta (A) to the E and SE of Grand Isle (O), the outline of Lake Pontchartrain (B) to the N and the Gulf coastline (C) to the NE.

IMMEDIATE DELIVERY

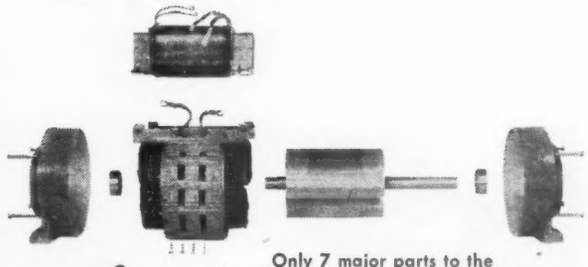
on the BEACON BURN-OUT PROOF LIGHT PLANT



The completely housed Beacon Light Plant unit.



The open type Beacon Light Plant unit.



Only 7 major parts to the Allmand burn-out proof generator.

GENERATOR: The Allmand Brushless Generator, used in the Beacon Light Plant will **not** burn out. This generator operates without brushes, slip-rings, or commutator. The only moving part is a permanent magnet rotor which spins on sealed ball bearings requiring no lubrication. The burn-out proof armature is of all-welded construction and contains no wire. It is wound with 5/16" solid copper rod capable of carrying three times the rated output of the unit. Available in 3, 5, 7, 10 KW ratings.

ENGINE: All Beacon Light Plants are powered by Continental Red Seal liquid cooled industrial engines. Models available for Diesel, Gasoline or Natural Gas fuel consumption. Units are engineered to run at slow speeds for maximum engine life with ample reserve power to handle heavy overload conditions.

USES: The Beacon Light Plant has been designed to handle all types of industrial lighting and welding requirements. The skillfully designed current control produces a stable, quiet, smooth arc that strikes instantly on all heats. Immediate voltage recovery makes arc easy to strike and maintain.

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tion areas are seldom detected beyond 200 miles. Experience with the 10 cm radar installation at Grand Isle shows a few returns beyond 200 miles. The greatest of these returns was 250 miles from a thunderstorm near Panama City, Florida.

Precipitation from other lower altitude cloud formations, such as widespread rain or heavy drizzle from warm fronts, is seldom detected at distances greater than 100 miles. These precipitation types do not have strong gusty winds or sudden strong wind shifts and are not ordinarily hazardous to water operations. They have, however, on occasion indicated areas of storm formation that resulted in increases to steady 20 to 30 mph onshore winds and consequent appreciable deterioration in sea conditions affecting efficiency of offshore operations.

A factor influencing distance of detection is the vertical temperature and humidity gradient in the atmosphere. Fig. 4 shows the altitude required to detect an object at various ranges assuming a standard atmosphere. But since atmospheric characteristics are not always standard, there are departures from the ideal case. In unusual situations the beam may be trapped in an atmospheric duct, caused by rapid vertical decrease in moisture and/or increase in temperature, in which case it follows the curvature of the earth. When this happens, abnormally great detection distances along the earth's surface may result. This is usually observed along the Gulf Coast at night after cold, dry air has moved in from the North. Fig. 5 is an unusual example of this anomalous propagation.

In weather observation radar is valuable for locating and determining the intensity, growth, and movement of convective cloud systems. This is particularly true when cloud cover, fog, or darkness renders ineffective visual observation of cloud systems from government weather stations. Radar is superior to visual observation in that it permits pinpointing of the location of precipitation areas, determining their areal extent, intensity, movement, and whether precipitation is increasing or dissipating. Also, it provides an accurate determination of the number of storms per unit area and/or the ratio of storm area to total area. These data, combined with other data available to the meteorologist, provide information on airmass characteristics, stability of the atmosphere, and rainfall distribution. All these ultimately affect the wind and consequently the sea conditions.

Weather Types

In weather forecasting consider first, applications in connection with tropical squalls. Such squalls develop during the months from June to October over coastal Louisiana and the Gulf of Mexico. Usually these squalls are 1 to 10 miles in diameter, Fig. 6, and roughly oval or circular in shape, but occasionally large squalls have been observed up to 100 miles in diameter, Fig. 7. This is unusual but is extremely important to detect during the hurricane season, since the coalescence of tropical squalls into areas as much as 10,000 sq miles or more is an indication of the development of the most serious weather hazard to offshore operations, the fast moving tropical storm that forms close to offshore operations.

Comparison of radar scope photographs with recording anemometer traces over a period of two hurricane seasons indicates that the winds associated with the small tropical squalls depend on the movement and intensity of the storm, while the duration of the winds is a function of the size and age of the storm. For example, surface winds range from 20 to 30 mph for a 5 to 10-minute period for a storm 1 to 2 miles in diameter and of moderate intensity; 40 to 50 mph for a 10 to 15-minute period for storms 10 to 20 miles in diameter and of moderate intensity. Large tropical squalls may be associated with active tropical cyclogenesis or may occur in an isolated inactive state. The latter are characterized by winds 30 to 40 mph of several hours' duration, causing increases in wave heights of 8 to 10 ft in the open sea.

Consider next, application of radar in connection with line squall activity. A line squall is a line of thunderstorms, usually oriented northeast to

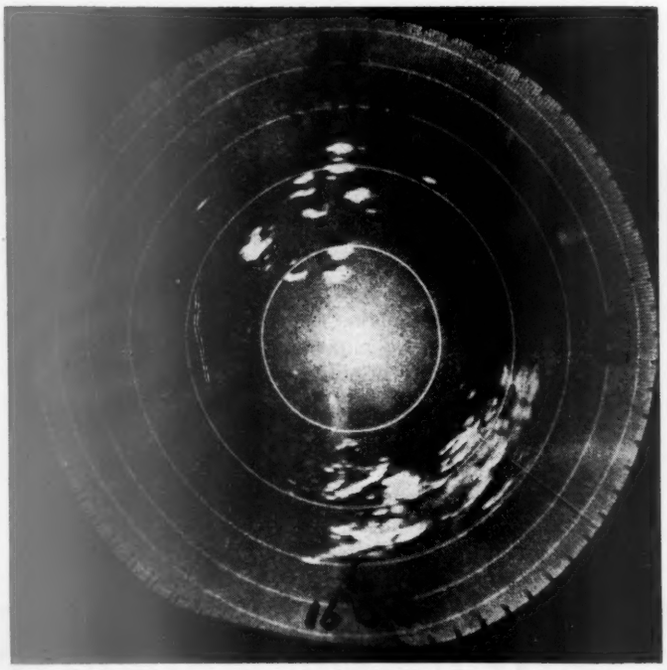
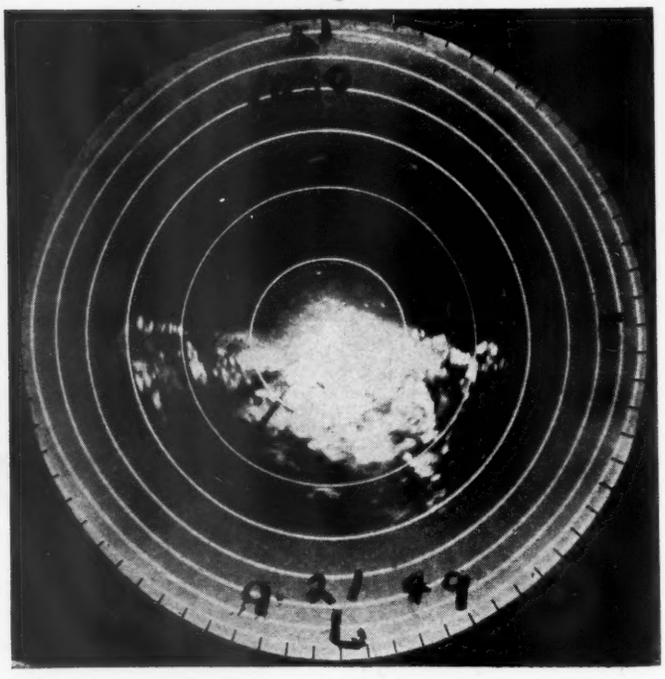


FIG. 6. Photograph showing individual tropical squalls to N and a large tropical squall area to the S formed by the coalescence of small tropical squalls. Echoes in the center are those returns from Grand Isle and surrounding terrain and rigs.

FIG. 7. Photograph of a tropical squall area that approached from the SE, causing 30 to 40 mph SE winds for approximately two hours resulting in a maximum 7-foot wave.



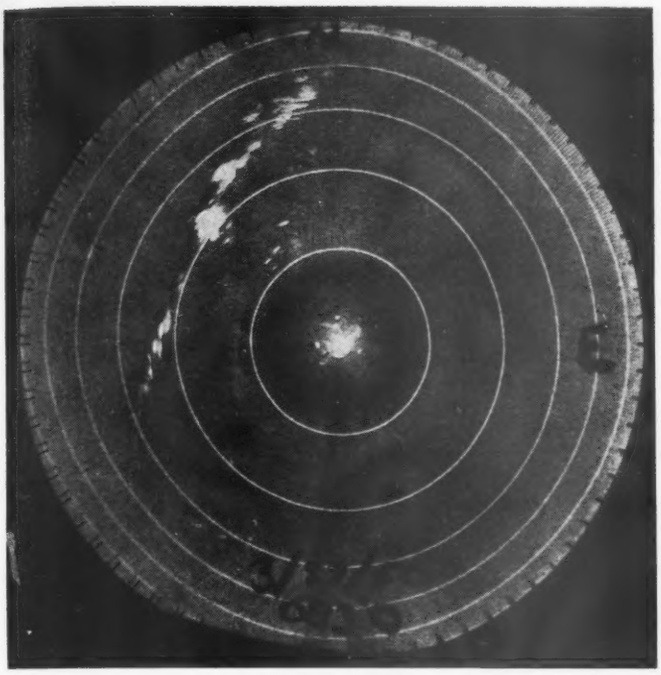
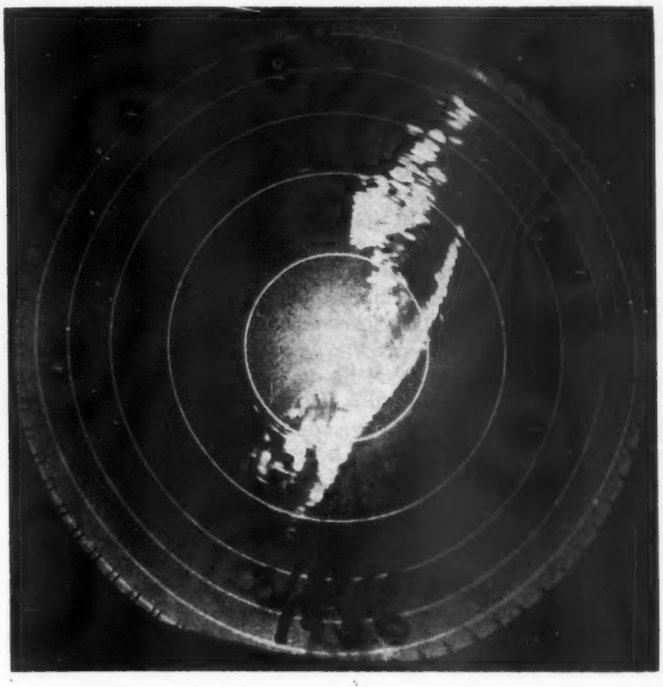


FIG. 8. Photograph showing squall line associated with a norther (cold front) soon after it was first detected. Forward speed was found to be approximately 25 mph and was forecast to arrive at Grand Isle at 12:30 PM. The center echoes are the ground returns normally received.

FIG. 10. Below, photograph of squall line two hours later, still moving SE but decreasing in forward speed.



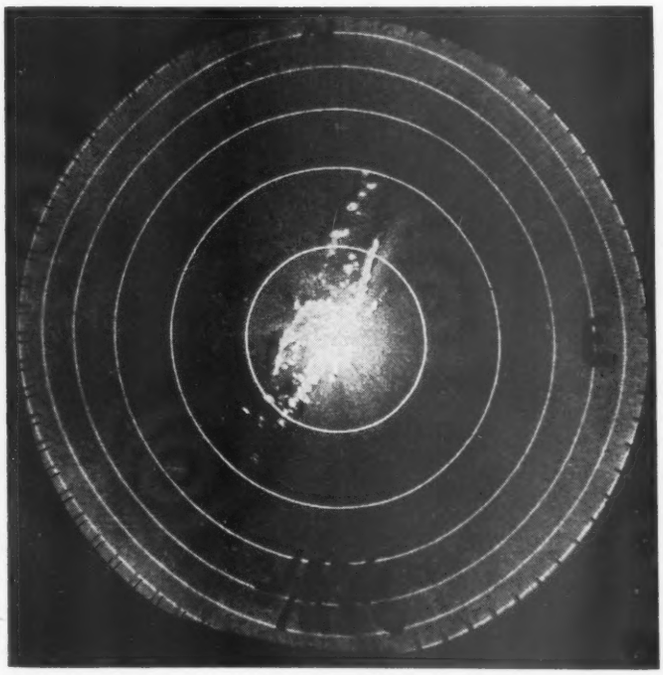
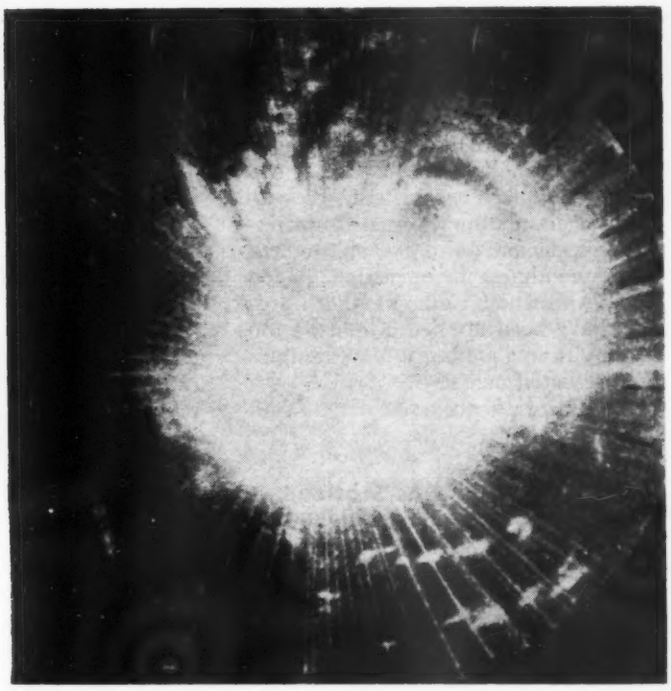


FIG. 9. Photograph of the squall line when just west of Grand Isle. It arrived at 12:40 PM with heavy rain and a wind shift from light S to strong NW winds with gusts of 40 mph.

FIG. 11. Below, photograph of a hurricane on radar scope. Notice the spiral banding of the squalls, and the dark eye (lower left), typical of all hurricanes, both due to the strong circular wind systems. The eye indicates the approximate center of the hurricane in respect to wind and pressure. (Origin of photograph unknown.)



southwest, Figs. 8, 9, and 10, which moves roughly perpendicular to its axis in an easterly direction. Line squalls are accompanied by abrupt wind shifts into the west or northwest. The maximum winds may be from a southerly direction ahead of the squall or from the west or northwest after it passes. Wind speeds of 40 to 50 mph are common in line squalls and 80 mph gusts have been recorded in the most severe squalls.

As line squalls are associated with large scale weather situations, their development can be anticipated 24 to 48 hours in advance in the general area of operations. The precautions that may be required in connection with line squall activity ordinarily require no more than an hour; hence, it is not practical to take precautions on the basis of a 24-hour forecast that may be in error by several hours. Instead of this, the line squall is detected and tracked by radar and precautions are restricted to the danger period that can be ascertained through use of radar data with an accuracy of 15 to 20 minutes.

In connection with any operation requiring precaution against local sudden wind or wave shifts the radar permits a maximum use of favorable operating conditions without sacrificing safety. A half hour or less is usually enough time for the radar operator to determine the speed of the line squall, thus a warning of 3.5 to 7.5 hours in advance can be supplied using the radar.

Radar Weather Warnings

The application of the weather warnings, which radar permits, reduces to practically nil the possibility of a severe sudden wind striking an offshore rig with no warning. The safety to personnel and the monetary saving that is realized from such warnings in the avoidance of major equipment damage, are of course intangible. Tangible benefits are realized, however, through a consistent week-to-week accumulation of small improvements in efficiency and the achievement of a smoothness in operation. A log of cases in which radar weather warnings have been applied would be too lengthy to include but a few examples are presented below.

Barge work is quite sensitive to sudden wind or wave changes. Unloading or loading barges requires less than 3-ft seas to be entirely safe and efficient. Tropical squalls, line squalls, or a norther can increase sea conditions above the 3-ft limit in a matter of minutes. Also a sudden wind shift or increase in wind can force a barge against other boats or structures, causing considerable damage and possibly breaking hawsers or oil lines. Radar warning of pending squalls or squall lines gives sufficient notice to move barges to safe positions around the ships or structures. Certain stages of construction work, where a derrick barge or LST is in use, become hazardous when seas reach 4 to 6 ft in height. Radar weather warnings provide adequate notice to check mooring of the barge, secure cranes if necessary, lash down material that can be moved by wind or rocking of the barge, or avoid a situation where a heavy load is being lowered from the barge to a stable platform under hazardous wind conditions. Other operations rendered hazardous by sudden severe wind changes are buoy laying, picking up chain to moor LST's or drilling barges, seismographic work, and making a trip with the drill pipe.

To cite a specific example, a deepening low pressure moved northeast over Missouri, and the norther associated with it reached Grand Isle on March 27, 1950. The March 27, 12:30 a.m. synoptic map showed the cold front of the norther extending in an arc from the center of the low pressure to St. Louis, then to Little Rock, Houston, Corpus Christi, and southwest into Mexico. None of the operations in progress in the Gulf was sufficiently critical to be terminated on the basis of the routine 24-hour forecast of the norther that was expected to be accurate within 8 hours, thus it was decided to await the more accurate radar warning before taking precautions. The front of the norther with associated thunderstorms was first detected 100 miles northwest of Grand Isle by the radar at 8:30 a.m., Fig. 8. Subsequent observations indicated the speed of the front at 25 mph, and at 9:30 a.m. it was estimated that the front would pass Grand Isle at approximately 12:30 p.m. with heavy rains and gusty northwest winds reaching 45 mph.

On receipt of this information precautions were scheduled for completion prior to the arrival of the norther. These included moving a barge from alongside an LST, towing an LST derrick barge that was unloading heavy equipment away from a platform, and postponing a trip into the Gulf with a supervisor boat until the afternoon. The norther arrived at 12:40 p.m. with accompanying rain, and a wind shift of 10 to 15 mph from south to gusty northwest winds reaching 40 mph, Fig. 9.

Hurricanes and Tropical Squalls

Weather radar is also essential in locating and tracking tropical storms and hurricanes, Fig. 11. During the hurricane season when tropical cyclogenesis is anticipated from surface and upper air synoptic maps, hurricane reconnaissance aircraft of the Air Force or Navy are dispatched to the area of development. Quite frequently radar observations using airborne radar are utilized to determine the location of the hurricane center. Radar is particularly valuable on high-level night sorties or when a low-level day sortie into the hurricane is considered dangerous.

The value of radar in offshore oil operations depends considerably on the forecast problem. In relation to hurricane warnings, reports from a single radar are ordinarily of limited value, particularly when 24 to 36 hours must be allowed for suspending drilling operations, securing working vessels, and removing men, boats, and barges to safe harbour, for by the time a radar in the rig area has located a hurricane, the winds have whipped the seas too high for safe evacuation. Either coastal radar at a distance from the rigs, or shipborne or airborne radar, can provide reports of great value. A single radar in the rig area is of considerable value in detecting conditions favorable for rapid tropical storm development, determining the course and intensity of the storm, and enabling the meteorologist to notify executives immediately when danger is over.

Acknowledgments

The author wishes to express his appreciation for the assistance and encouragement that A. H. Glenn extended in the preparation of this paper.

Bibliography

Glenn, A. H., and Graham, J. E., Outline of Wave and Weather Forecasting Techniques, T. P. 2546, *Petroleum Transactions*, A.I.M.E., February 1949.

Glenn, A. H., and Bates, C. C., The Meteorological and Oceanographic Aspects of Geophysical Prospecting, *Geophysics*, April 1950.

Glenn, A. H., Wave, Tide, Current and Hurricane Problems in Coastal Operations, *The Oil and Gas Journal*, June 22, 1950.

Graham, J. E., and Geyer, R. A., The Use of Meteorology in the Oil Industry, A.P.I. Paper No. 901-26-F.

Wexler, Harry, Structure of Hurricanes as Determined by Radar, *Annals of the New York Academy of Sciences*, Vol. XLVIII, September 15, 1947.

Wexler, Raymond, and Swingle, D. M., Radar Storm Detection, *The Bulletin of the American Meteorology Society*, April, 1947.

Booker, H. G., Radio Refraction in the Atmosphere, WEATHER, February 1948.

Ridenour, L. N., Radar System Engineering, Radiation Laboratory Series, McGraw-Hill, 1947.

Fink, D. G., Radar Engineering, McGraw-Hill, 1947.

Jones, R. F., Radar Weather Echoes, *Meteorological Magazine*, London, April-July, 1950.

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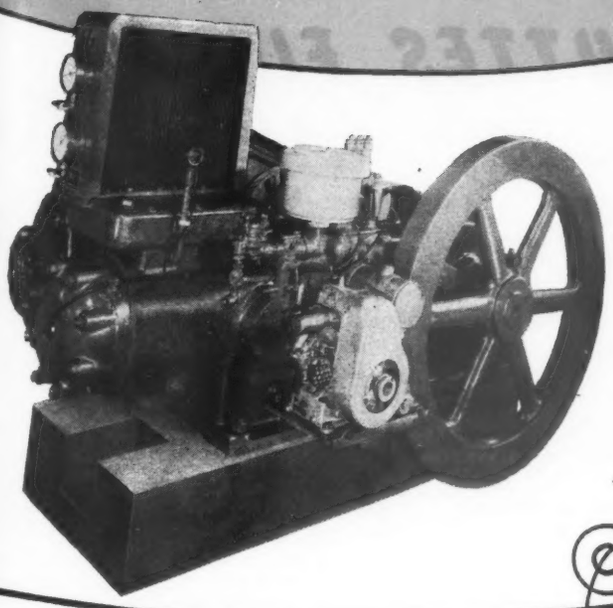

Engine side of an "Oilwell"-Lorain single-stage direct-connected compresser.

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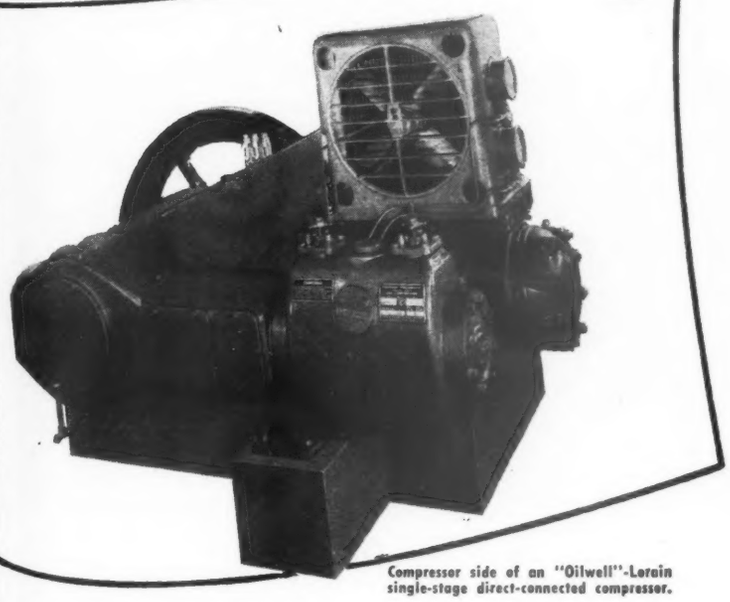

Compressor side of an "Oilwell"-Lorain single-stage direct-connected compressor.

BRIEF SPECIFICATIONS — 30 HP Unit

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Cooling System (compressor)	Radiator with pump	
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DRILLING AND COMPLETION PRACTICES IN

THE CHURCH BUTTES FIELD†

W. C. DINGER*

THE Church Buttes field is situated 50 miles west of Rock Springs, Wyoming, and 3¾ miles south of Lincoln Highway U. S. 30-S, and across the line between Sweetwater and Uinta counties.

The geological and geophysical work was done on this area before the acreage was unitized, and the unit agreement was completed prior to drilling the first test well. Union Pacific Railroad Company's interest is 49 per cent, with the remaining 51 per cent being owned by Mountain Fuel Supply Company.

Production was discovered in 1946 by the completion of Unit Well No. 1 at a depth of 12,666 ft in the Dakota sandstone. Eleven additional wells have been drilled and a hydrocarbon removal and dehydration plant has been completed since that time. Of the 12 wells drilled in the field, 3 have been nonproductive.

Locations of the wells and plant are shown on the surface map of the unit area attached to the back of this paper.

Description of Reservoir

Structure. The Church Buttes gas field is an elongated anticlinal structure approximately 8 to 9 miles long and 3 to 4 miles wide, trending in a north-south direction. The Dakota sandstone of Cretaceous age is encountered at depths ranging from 12,400 to 13,000 ft in three main zones separated by relatively thin shale sections. The Frontier sandstone, above the Dakota and separated by the Aspen shale, has been cored and tested but commercial production is not present in this formation. The Nugget sandstone, at approximately 14,500 ft, also has been cored and tested but salt water was recovered in the drill stem test. No major faulting has been found in the structure by drilling. A generalized stratigraphic section of the formations penetrated may be found at the back of this paper.

Sand Characteristics. The reservoir sandstones of the Dakota formation are of Cretaceous age. The three main sands are light gray, fine to coarse, hard to soft, and are separated by light gray, bentonitic, hard shales, which have a tendency to cave. The sands are very well consolidated, and they range from 115 to 173 ft aggregate net thickness in well bore exposures. The core data consist of complete analyses of all three zones. The average porosity of the reservoir sands in the wells drilled ranges from 8 to 21 per cent and the permeability variation is appreciable, with individual values ranging from 14 to 750 millidarcies in the producing sections. It is very difficult to stratigraphically correlate the 3 main sands because of lenticularity in the Dakota formation and the variation in porosity and permeability. Part of the sands have permeabilities of less than one millidarcy, but these are not considered commercially productive since a section of this nature was perforated and tested in one of the wells.

Reservoir Fluids. The original fluid saturations in the Dakota sands range from 41 to 56 per cent water, and from a trace to 3 per cent oil saturation. The fluids as recovered at the plant range from 6 to 8 bbl condensate, and 1 to 2 bbl water per million cubic feet of gas produced. The condensate has a tank gravity of 53 API. At the time of the discovery the pressure in the reservoir was about 7040 psi at the datum depth of minus 5835 ft, subsea, and the temperature, 250 F. After completion of Unit Well No. 1, surface samples of the liquid and gas were studied for the purpose of determining the properties of the samples when recombined in the produced ratio and under the pressure and temperature of the reservoir. It was found from these tests that the reservoir gas is a retrograde gas and that no hydrocarbon liquid is present in the reservoir.

Drilling and Completion

Drilling is relatively uncomplicated in the area as there are not any of the hole difficulties encountered such as crooked holes, lost circulation or drilling mud problems. A 12¼-in. surface hole is drilled and opened to 17½ in. with 250 to 300 ft of 13⅜-in. casing set and cemented to the surface. The only disturbance in the mud is encountered when the trona beds in lower Green River formation are drilled at 2600 to 2800 ft. Trona is essentially sodium carbonate, which increases the pH, viscosity, and gels of the mud. Additions of water and chemicals to lower the pH of the mud are made without any difficulty, however.

The intermediate string of casing is 9⅝-in. OD, 6000 ft long and cemented with 600 sacks in a 12¼-in. hole. As the float collar and cement plug are being drilled, the drilling mud is converted to a calcium base mud using lime and calcium ligonsulfonate. A crude oil is also added to emulsify the mud and used to total depth in drilling the 8⅝-in. hole.

Before the 6⅝-in. production string is brought to the well, each joint is hydrostatically tested to 6000 psi for one minute.

In the first wells drilled the production string was set through the sands and the zones perforated. It is now the practice, however, to set on top of the Dakota, drill out, and hang a slotted liner. The production string is cemented with 650 sacks, using centralizers and a temperature survey is run to determine the top of the cement behind the casing.

Before the float collars and/or plugs are drilled, each string of casing is tested for one hour. The 13⅜-in. casing is tested to 1500 psi, the 9⅝-in. tested to 2500 psi and the 6⅝-in. production string tested to 5400 psi. In these tests that part of the christmas tree involved is also tested and the tubing head is tested with water to 10,000 psi prior to installation.

In drilling the wells to this depth, 120 to 125 days are required and the number of rock bits varies from 136 to 147. The drilling time and number of bits have been reduced since the oil emulsion mud has been used.

Diamond coring is used for all drilling from the top of the Dakota through the three main sands, and usually re-

†Presented before the spring meeting, Rocky Mountain District, API Division of Production, Casper, Wyoming, April 19-20, 1951.

*Petroleum engineer, Mountain Fuel Supply Company, Rock Springs, Wyoming.

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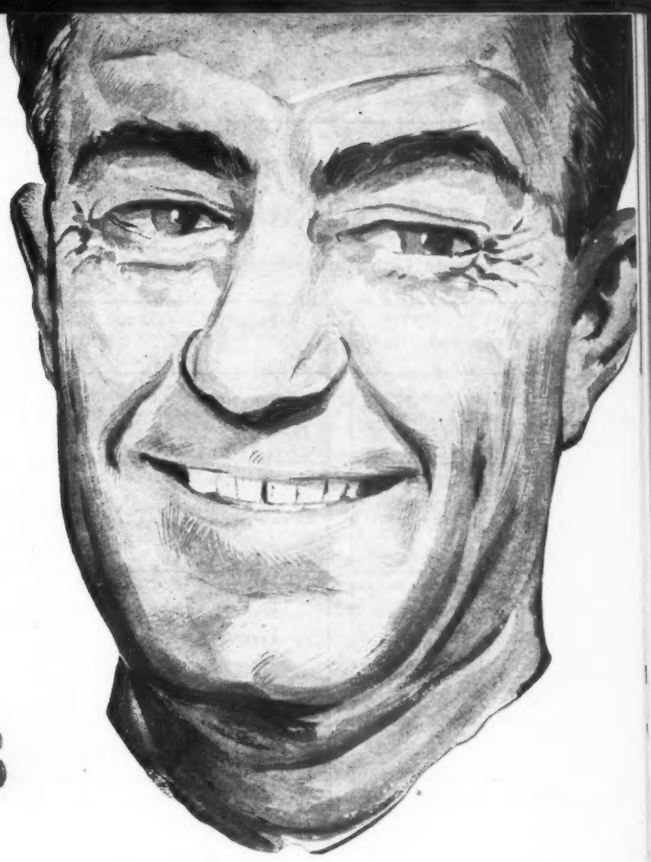

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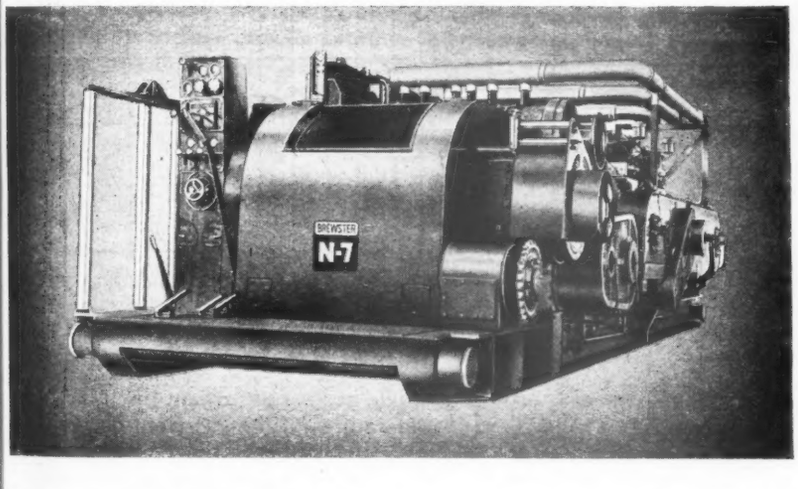

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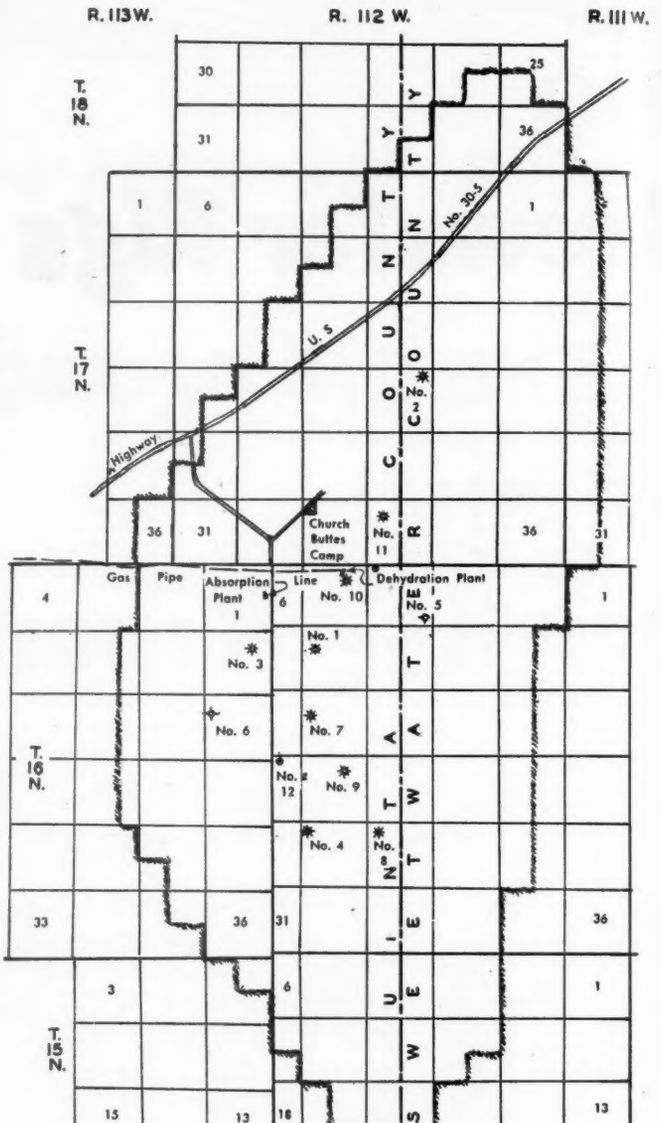
TERTIARY	BRIDGER FORM. 1235 FT.	Greenish gray calcareous shale, with interbedded white to light gray limestone, calcareous sandstone, and oil shale.
	GREEN RIVER SHALE 1735 FT.	Green, gray and tan shales and sandstones, in part bentonitic and numerous thick beds of volcanic ash.
	WASATCH FORM. 2090 FT.	Gray, brown and red shale, in part sandy, with lentisular bodies of medium-grained light gray sand.
	FORT UNION (?) FORM. 1890 FT.	Light to dark gray shales, in part sandy and carbonaceous with numerous beds of light gray medium-grained sandstone, and some coal.
CRETACEOUS	ADAVILLE FORM. 1498 FT.	Light to medium gray, fine to coarse, slightly carbonaceous sandstone, interbedded with gray sandy shale, and numerous thick seams of coal.
	BLAIR FORMATION 739 FT.	Upper part essentially dark gray, silty to sandy shale. Lower part is mainly light gray coarse sandstone with interbedded shale.
	HILLIARD SHALE 2323 FT.	Medium to dark gray, silty to sandy, calcareous shale with thin beds of limestone and fine-grained sandstone.
	FRONTIER SANDSTONE 75 FT.	Upper part is mainly dark gray, silty to sandy, partly carbonaceous shale with some thin coals. Lower part is light gray, medium-grained, hard, tight sandstone.
	ASPEN SHALE 375 FT.	Dark gray to black, dense to silty, calcareous shale, with frequent beds of light gray, hard bentonite.
	DAKOTA SANDSTONE 224 FT.	Light gray fine to coarse, hard to soft sandstone, separated into three main zones by light gray, bentonitic, smooth to sandy, hard shale. Producing gas zone.
JURASSIC	MORRISON FORM. 700 FT.	Green, gray, purple, red, dense shale, with thin beds of light gray hard sandstone.
	CURTIS FORMATION 103 FT.	Dark gray and greenish-gray, oolitic, glauconitic, limestone.
	ENTRADA FORM. 140 FT.	Brick-red, siltstone and silty shale.
	CARMEL FORM. 612 FT.	Interbedded dark gray, limestone, pink gypsum, and gray, red and green gypsiferous shales.
	NUGGET SANDSTONE 129+ FT.	White, fine to medium-grained, cross-bedded sandstone.



Map of Church Buttes Field.

quires two or three diamond heads.

The earlier wells were completed with a packer on the tubing with the annulus filled with mud, but the later wells were completed without the packer. If corrosion should develop in the tubing, then it would be possible to lubricate the corrective chemicals into the annulus. In the tubing caliper surveys that have been run, there is no conclusive evidence that corrosion is taking place. Also, samples of water from the plant have been tested for iron content increases, but these data are not conclusive.

The tubing is hung 30 ft above the liner hanger, mud displaced with water, and the wells completed.

After the wells are completed and the drilling derricks are removed the valves of the christmas trees are fitted with extensions and blow-off lines in case of emergencies at a later date.

Bottom-hole pressures are taken immediately after the wells are cleaned and before being put on production. Also, reservoir pressures are taken yearly on all wells to determine the amount of pressure decline in the reservoir for the amount of gas produced since the preceding survey.

Initial shut-in surface pressures are 5400 psi, and the flowing pressures vary from 3000 to 4500 psi, depending upon the rate of flow. The first reduction in the wellhead pressure is taken after the gas travels a short distance and through one side of a two-pass indirect heater. After the gas expands through the adjustable choke, it is again reheated as it travels through the second pass of the heater. It then enters the meter house on the downstream side of the heater. It is necessary to install the heaters near the wells to prevent the formation of hydrates in the flow lines due to the cooling on expansion to the flow line pressures. The pressure on the flow lines to the plant is 950 psi, and the hydrate point at this pressure is approximately 64 F. On the longer flow lines it is necessary to install intermediate heaters to prevent the flowing temperatures of the gas from decreasing to this temperature. All flow lines are buried 6 ft and accurate records are kept of the daily temperatures at critical points to maintain the temperature of the gas above the hydrate temperature.

The gas enters the plant at this pressure, the hydrocarbons and water are removed, and then the gas enters the main line to northern Utah at a pressure of 450 psi.

Acknowledgment

The author wishes to express his appreciation to W. T. Nightingale and Mountain Fuel Supply Company for having granted permission to prepare and publish this paper and the valuable assistance rendered by J. T. Simon, chief petroleum engineer, and M. M. Fidlar, chief geologist, Mountain Fuel Supply. * * *

Fracture Contact Affects Energy Behavior Between Wells

F. R. COZZENS*

OIL bearing reservoirs become primarily depleted when producing wells and their complexly fractured sand-bore drainage systems are plugged and abandoned. These once-productive drainage systems may constitute permanent cavities or channelled systems, extending from the top to the base of the sand, each having an effective radial area of 50 to 100 or more feet. Assuming the original wells have been plugged so that no annulus leakage exists to upper formations, a build-up of pressure is possible within such drainage channels and fluid can be moved through the system at a fairly uniform rate, provided the radius of fissures is enveloped in unfractured sand.

An obstinate recovery problem generally arises, however, when this shell of sand is punctured, purposely or accidentally, so that channel contact is established with an open well. Any such puncturing of the drainage system might unite two channelled systems, and pressures from all parts of the combined system may be conveyed to, and released at the open bore. From then on, connecting fractures provide detours for gas or air driving energy, and oil may be lost at various by-passed points along the route.

Energy release through interconnected sand-bores often increased the volume of oil for an indefinite period during the early stages of primary recovery. A generally favored practice was to intentionally 'shoot into' abandonments by using heavy charges of nitroglycerine in nearby producers. The objective was to add the fissured area of the abandonment to that of the new well, thus enlarging by about twice its capacity for drainage.

In virgin sand, such practice seemed logical, inasmuch as fluid content was high and reservoir pressures were sufficient to force a considerable fraction of oil into the channels. Introduction of "compressor-made" energy changed the routine of primary fluid movement, however, because reservoir pressure as a driving medium is practically nil following natural depletion, and must be rebuilt by "pressure-heads," developed and expanded from input wells.

Pressure-heads do not unite uniformly in a sand, nor do they replace natural energy in all sand reservoirs, but in following courses of least resistance the driving agent usually reaches and occupies cavities and channelled areas ahead of the oil. An extended system of fissures that served as drainage routes and was mainly responsible for a faster flow of oil during primary recovery may become an escape route for secondary pressures. As little or none of the original energy remains in the segments of fissured sand that may comprise several hundred cubic feet of formation, its oil content may be left in place, except for a minor percentage that might flow by gravity to some nearby producing well.

Effect of "Break-Throughs"

By-passing of a repressuring agent through cavities or channels is revealed initially during secondary recovery by a premature break-through of energy at certain producing wells. These break-throughs occur most frequently in areas where new wells are drilled within a radius of 100 ft from an abandoned well. Once contact is established between well bores, these "energy-escape" channels cannot be eradicated with certainty by any method known. Under favorable conditions, however, they can be bridged or plugged. Coring reveals, however, that most well bore connections and resultant by-passing can be prevented by the retention of a buffer strip, or "shell" of unfractured formation between open wells and abandonments. Sand-shells, thus situated, have been effective for the purpose where wall-thickness was less than 3 ft, and in the arrangement of pressure patterns, requiring close in-drilling, shell wall-retaining methods are now being carried out in lieu of pattern distortion. Under such circumstances, distance between a newly drilled well and an abandoned well becomes a factor in permeability control, and the new well bore at completion, is provided with an effective receiving radius by the use of: (a) heat; (b) low-strength explosives, and/or (c) acid.

The use of heat in well bores is not new in oil-field practice, but with the present wide-spread availability of electricity, heating procedures have become more common and of greater effectiveness. The purpose of heating a well bore is to increase permeability without shooting or acidizing. Heating is practiced particularly in wells situated 50 to 75 ft from a known abandonment. Temperature effects upon oil reservoir rocks are not clearly understood, and benefits derived from well bore heating may be due to redistribution of oil within the affected area, or to physical changes in the structure itself. The latter might include a localized radius of fractures caused by sand expansion. Nevertheless, certain permanent changes in permeability to fluids are known to occur when hot water is applied to a sand-face for a sufficient period of time. Permeability usually increases while the water is heated, then decreases when the heat is turned off, however, it generally remains considerably higher than the initial value after a series of treatments are completed.

Extent of penetration behind the sand face is much greater where, as in the case of input wells, a low fluid pressure can be applied to the well while the heater is in action. Limited sand-face penetration can be accomplished in producing wells, however, provided incoming pressure or energy from the sand is not in evidence at the wellhead. Temperature effects are produced by electric energy, steam, air-gas mixtures, and to a lesser extent by chemicals. Electric energy units are often constructed on the job under the supervision of a qualified electrician, or may be purchased or 'rented from service companies, in sizes and designs to suit requirements.

Heat-Treating Wells

The procedure for heat-treating producing wells is to clean the new well bore to the base of the sand, and allow it to refill with fluid to about two-thirds of its capacity. The heating unit is then inserted into the fluid, and anchored about two feet off bottom. The unit remains in contact for 40 to 48 hours. During most of this time the fluid content of the bore should be held at a temperature of 200 to 230 F. The fluid level rises in the bore when heated and should not be permitted to extend above the casing-shoulder, or into any uncased beds of shale or porous formation over

*Equity Oil and Gas Company.

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the producing sand. An accurate thermometer and a fluid level measuring device are essential for the work. Recordings made on several wells in a project may reveal that some types of sands absorb heat faster than other types, and that temperatures are retained in tight, restricted zones over longer periods of time. Consequently, benefits may be greatest in areas of lower permeability, assuming that the heat can be maintained in the formation for a long enough time.

In most wells, it is advisable to remove the heating unit after 48 hrs of continuous service. After being bailed and washed out, the well is permitted to remain open three to five days. Then it is bailed down again to about two-thirds its well bore capacity. The heater is run again for another 40 to 48-hr period, and temperatures and fluid levels rechecked. Two or three heat applications, interrupted by standing, or cooling-off periods, are generally sufficient.

All sand, sludge, and other residue are cleaned from the well bore, and the sand-face washed down several times with salt water or brine. The well is tubed and equipped for pumping after residue ceases to drain into the bore. In heat-treating a prospective input well, procedures differ somewhat. The fluid subjected to heat is forced into the sand-face instead of being drained from it, and the heater must be of a size and design small enough for insertion down the tubing.

Small but satisfactory units for the purpose are now being provided with contacts at either end, and are enclosed, while in action, in a string of ¾ to 1-in. retainer pipe. The pipe is plugged at the base and filled to a depth of 10 to 12 in. with mercury. A single lead wire is connected with the contact at the top of the heater, and, when the unit is lowered down the retainer pipe into position, the base contact is established through immersion in the mercury bath, so that the retainer string serves as the return conductor. By the use of a packing gland or perforated plug at the wellhead, water at low pressure is introduced down the tubing and around the retainer pipe while the unit is in action. It is rarely necessary to remove tubing for bailing unless considerable sediment accumulates in the bore.

Steaming Wells

In lieu of electricity, steam serves as a dependable well bore-heating agent, where boilers and/or steam generating units are available. Steaming likewise requires that a treated well be tubed, and, for maximum effectiveness, steam should be delivered into the well bore under a working pressure of 125 to 150 psi at the boiler or heater. Well bore-heating with air-gasoline vapor mixtures, supplied from a portable compressor, and ignited at the bottom of the well by fuse, is also practiced in limited areas where trained service crews are available.

Heat absorbing chemicals, principally carbon dioxide snow (dry-ice) have favorable effects on permeabilities of certain types of sands. Heat generating chemicals, such as lye-aluminum combinations are also useful where excessive quantities of sludge are not formed. Regardless of the agent involved or the method of its application, however, the use of temperature changes to increase sand-face permeabilities is an emergency measure, and is not intended to replace established sand-fracturing processes, except on wells where connection with an abandonment is imminent. Ultimate benefits on temperature-treated well bores compare favorably with those obtained from uniform, but restricted shot-fracture patterns.

Where well bores and sand-fracture systems are separated, or the extent of undisturbed formation between wells

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is sufficient to permit a limited radius of fractures, permeabilities are generally increased by the use of low-strength explosives. The strength of an explosive does not necessarily control its effectiveness, however, because shot effects (fractures) are created upon sub-surface rocks by the nature and behavior of strain waves or energy pulsations produced at the time of detonation. As sand with many fractures and channels is weaker and more vulnerable to fracturing than more solid sandstone, it is contended that a high-strength, rapid-velocity explosive, even in small quantities, will expend its most potent strain waves, and cause greatest fracture penetration toward the weaker sandstone, whereas, a low-strength, slower-acting explosive will not reduce the number of strain waves, but will, with supplementary measures, reduce the radius of penetration.

In restricted fracturing between well bores, radius control is essential, and explosives used for the purpose are: Nitroglycerine-dynamite, 40 per cent strength; gelatin, of equal strength; or its equivalent in solidified nitroglycerine. Just before running the charge, the well is bailed as dry as possible, and arrangements are made for detonation to occur before any considerable quantity of fluid has re-entered the bore.

Loading procedures differ somewhat from the usual practice, inasmuch, as the charge of explosives is run in twin shells of small diameters (2 or 2½-in.), placed alongside each other in the well bore, and extending from one foot below the top of the pay sand to one foot above its base. Where well bore diameters are not sufficient to permit running the two small shells, side by side, a single torpedo of larger diameter (4 to 4½-in.) is used; being made up of two or more stub-shells, placed end to end in the bore, and separated by 1-in. spacers. The purpose in using twin shells, or shell separations is to disrupt, or break the pattern of shot-energy pulsations. For some wells, the technique is extended further by filling well bore space around the shell or shells with coarse, dry sand.

The filler is not permitted to extend above the top of the shell, although a shield or wadding of wetted burlap is used to protect the cap and primer where it is necessary to remove casing before shooting. Shot concentration per foot of sand is generally equivalent to 2 to 4 quarts of liquid nitroglycerine. No stemming is used over these charges, and clean-out is usually shortened, because much of the residue is blown from the bore.

Use of Acid

In formations high in calcium (lime) content, well bore enlargement and restricted fissuring are often accomplished with hydrochloric acid solutions (15 to 20 per cent strength), or by a combination of acids and wetting agents, instead of by heaters or explosives. Some of the benefits of both mediums are derived. Regular acidizing service equipment, while preferable, is seldom necessary for this type of work, as the usual procedure is to run a packer on 2-in. tubing to the top of the pay sand, and to inject the acid down the tubing at low pressures, using oil pressure to force the agent into the formation. On certain wells, a priming charge is used, being a 20 per cent solution of inhibited hydrochloric acid that is poured into the well, allowed to remain against the sand-face for six to eight hours. It is then bailed out before tubing and packer are inserted for the regular job. Acid is seldom permitted to remain in the well for more than three hours after the pump is disconnected. During the cooling off, or standing period, well bore tests are made on the solution to determine its rate of reaction, after which, tubing and packer are removed, and the spent solution is bailed from the well.

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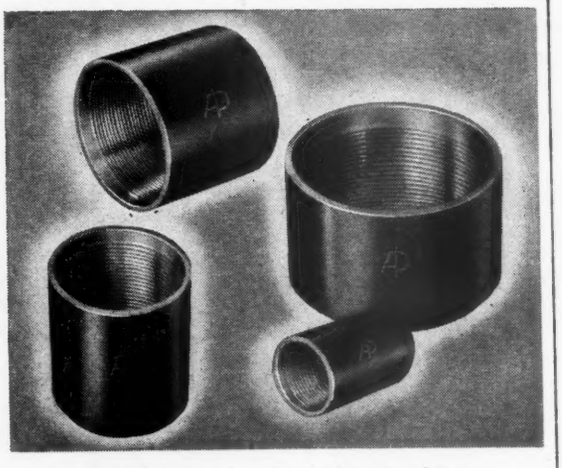

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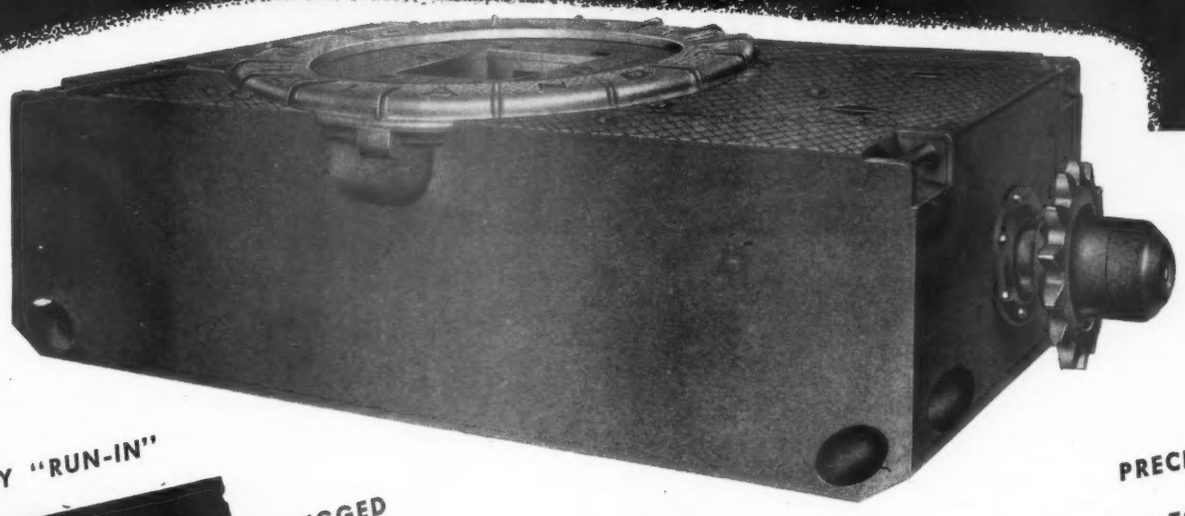

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Where a satisfactory increase in production fails to occur within a week or 10 days, the acid treatment is repeated, generally with a combination of two or more acids in addition to a suitable wetting agent. A thorough clean-out, including several well bore-washings with oil, is essential, following an acid treatment, because chemical reactions to certain elements of the formation often create sludges and water-soluble salts that adhere stubbornly to the sand-face and plug the pores.

In common with special applications of heat and explosives, previously described, restricted sand-bore fissuring with acid is an emergency measure to be practiced only in new wells located within the immediate vicinity of abandoned wells. Such emergencies occur frequently, however, because abandoned wells have increased steadily since 1860 until the present general ratio in many areas is seven abandonments, excluding so-called 'dusters', to one active producer. It is therefore quite obvious why only a very few pressure-patterns can be spaced and drilled without some new well being located close to an abandoned well.

Irregular spacing of wells to avoid old wells is practical only to a limited degree, and does not eliminate the menace of channels in the reservoir. Measures designed to prevent channel contacts between new wells and old wells should provide a more workable pressure build-up; allow surface-spacing of any desired pattern; and obtain more uniform movement of both fluid and repressuring agent through the oil reservoir. By-passing tendencies should be reduced, and consequently, more oil should be produced, and less oil should be left in the sand.

* * *

Syria Wants Oil Search

The Syrian Minister to the United States has advised private U. S. Oil companies through the U. S. Department of State that their interest in the oil exploration in Syria will be welcomed. The Syrian Minister stated that the present concessionaire, the Syrian Petroleum Company (subsidiary of the Iraq Petroleum Company) is abandoning its work as of August 15 after which date the most favorable area in Syria would be available for competitive bidding.

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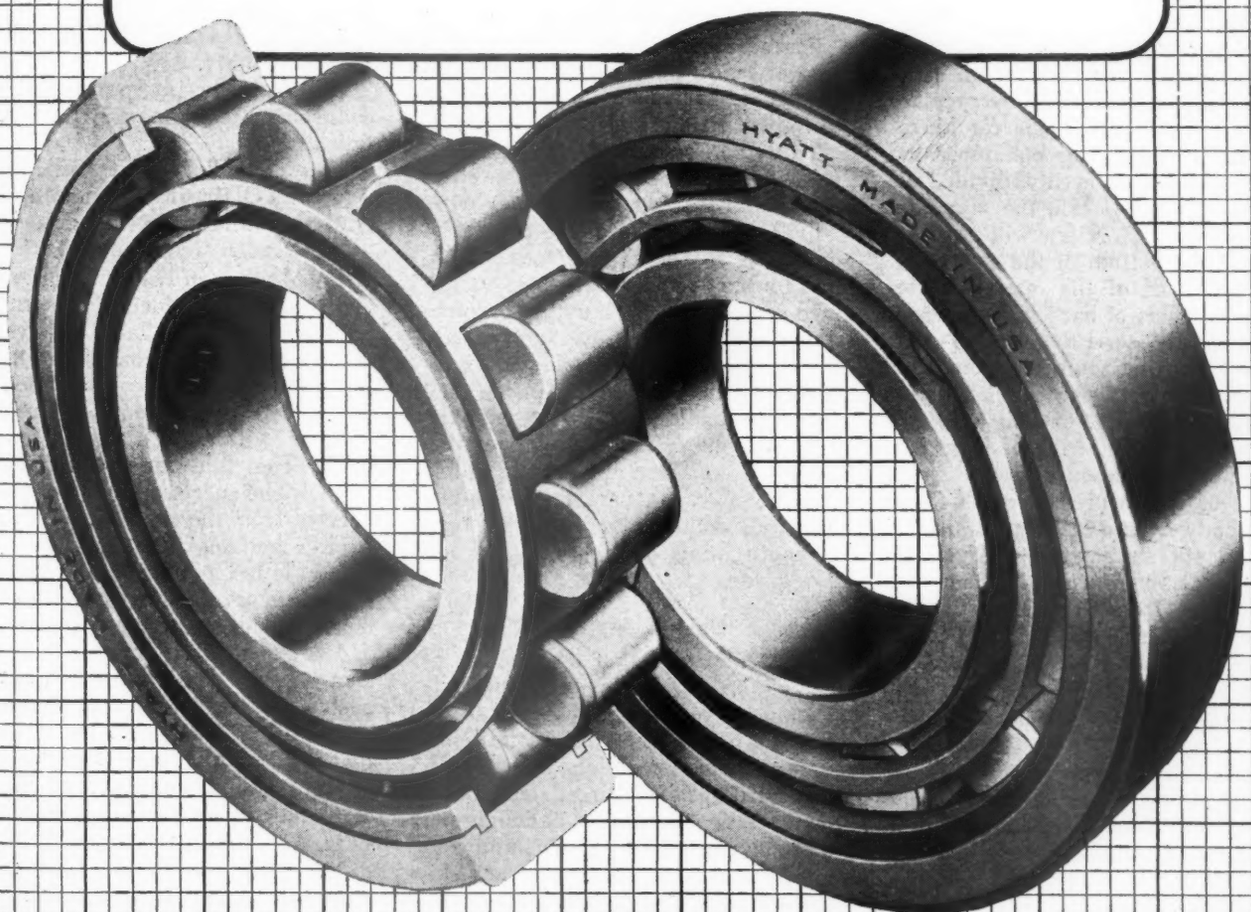


HYATT ROLLER BEARINGS

A Review

Casing String Design Principles and Practices†

J. O. HILLS*

PART 2—CONCLUSION

Design Practice of California Operators

A canvass of representative California operators indicates that casing string design is given careful consideration in the interest of safety and economy. Design practice conforms generally to the principles outlined in this paper, except as regards the use of buoyancy in design. When buoyancy is considered the conventional assumption is made that buoyancy acts over the entire length of the string.

All operators canvassed base their design loading for collapse on actual mud weight or formation pressure, and all make corrections for biaxial stress. Preference for collapse safety factors is about evenly divided between 1.25 and 1.125, the maximum used being 1.33. A few will go below 1.12 at the bottom of the string.

About half of the operators consider the effect of buoyancy on tensile loads and these use a minimum safety factor on joint pullout strength of from 1.8 to 2.0. The other half do not calculate the effect of buoyancy and use lower safety factors of from 1.63 to 1.8. A minimum allowable safety factor of 1.5 on yield strength of the pipe body is used quite generally.

Most operators use a safety factor of about 1.50 for bursting, but practice varies from 1.10 to 1.75. This large variation is due partly to differences in loading assumption. Also, bursting pressures are seldom critical in design and generally have not been given much study.

Practically all operators consider wall thickness an important criterion and do not necessarily run the minimum casing weights indicated by the nominal safety factors. For instance, many will not run 7 in. casing lighter than 26 lb per foot in combination strings.

†Presented at the spring meeting of the Pacific Coast District, Division of Production, American Petroleum Institute, Biltmore Hotel, Los Angeles, California, May 10 and 11, 1951.

*General Petroleum Corporation.

Design Procedure

The first step in design is to choose the safety factors, the loading conditions, and any limitation desired such as minimum wall thickness, minimum length of sections, maximum number of sections, etc. Throughout the design, conformance with all these factors must be maintained.

The next step in all design procedures must be the choice of pipe to meet the collapse loading at the bottom of the hole. It is essential to start at the bottom because the design for tension and corrections for biaxial stress are affected by the weight below each section considered. The pipe chosen for the bottom is continued upward until the collapse loading has decreased sufficiently to allow use of a lighter weight and/or lower grade. At this and subsequent changes, corrections must be made for the effect of biaxial loading.

Proceeding upward, the process of changing to a weaker pipe as permitted by the collapse loading is continued until tension or bursting becomes the limiting condition. Increasingly strong pipe, with allowable strengths sufficient to meet both tension and bursting loadings, are chosen for the top sections. Here, many combinations of weights, grades and joints are possible, but greatest economy usually results from choosing high strength joints on light weights and low grades.

Design Methods

It is desirable that the method of design be as simple as possible. It should not restrict the choice of safety factors, however, loading conditions, kinds of pipe and joints, or other design assumptions. Direct step-by-step mathematical methods, although not basically difficult to understand and apply, are time consuming and involve a great deal of cut-and-try computation. This is especially true if an attempt is made to compare various possible combinations of pipe in the string. A complicated or tedious procedure discourages search for the best design, and encourages the use of over-simplified assumptions.

A graphical method developed by W. C. Main and published in the information booklet of a pipe manufacturer[30] appears to be the best casing string design method available at present. It has these advantages:

1. Any desired mud weights, safety factors, and design assumptions can be used, and trials of various combinations of weights, grades, and joints can be made easily.
2. Even a rather complicated string can be designed in 15 minutes.
3. For each size of casing, all the necessary strength data can be on the design chart.
4. The finished design can be checked readily.
5. Relatively inexperienced personnel can learn to use the method quickly.

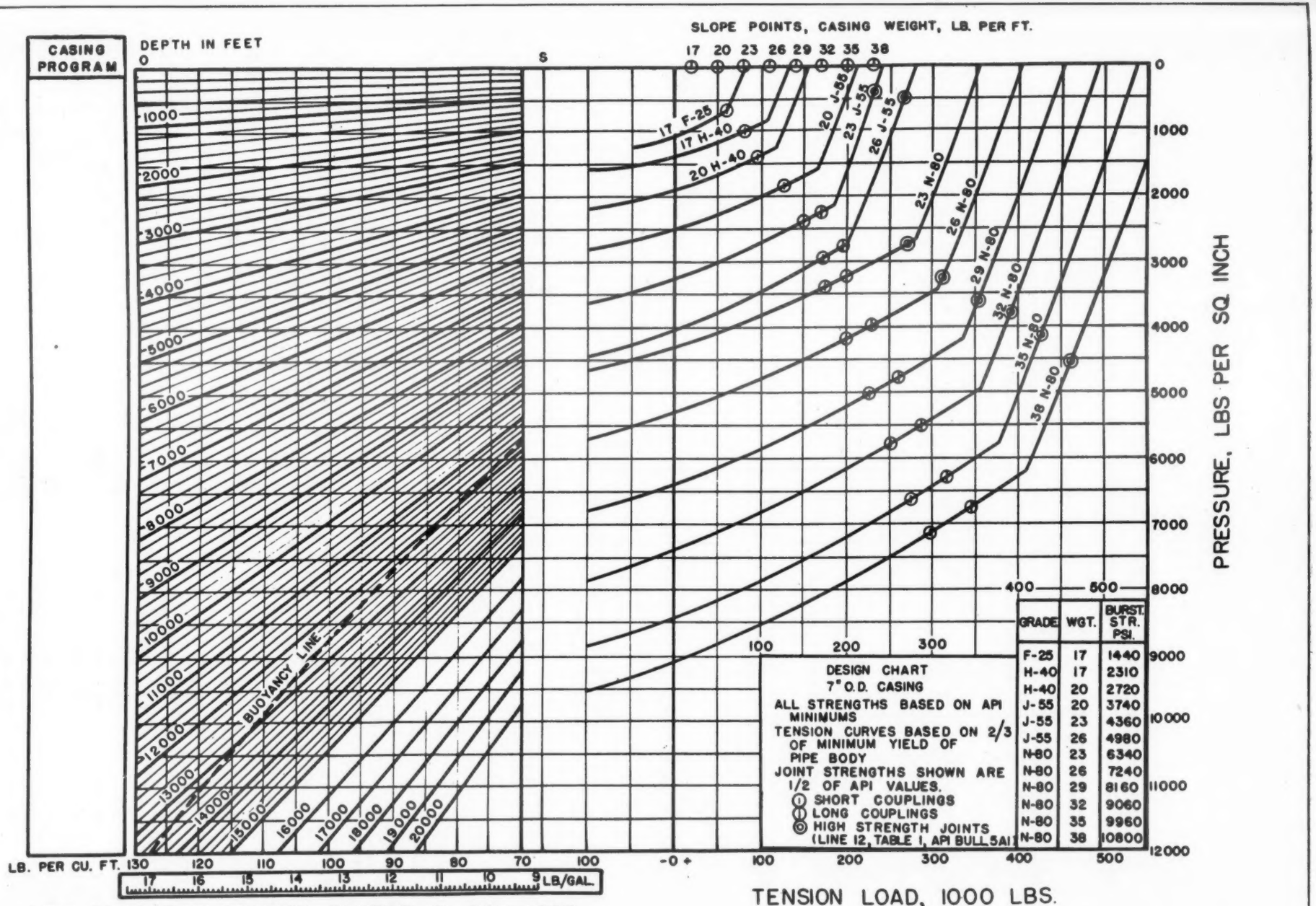
This method is illustrated by Fig. 9 for 7 in. OD casing. A separate chart is needed for each casing size.

This design chart provides:

1. A means of determining graphically the collapse loading in terms of mud weight and collapse safety factor. (Left hand section of chart.)
2. A graphical representation of the variation of casing collapse resistance with longitudinal tension load. (The right hand section of the chart.) The curves on this section are derived from the curve shown in Fig. 2 (Effect of biaxial stress).
3. Plotted points on the collapse strength curves showing allowable tension loads for various joints.
4. A means of constructing a tension load vs. depth curve of the type shown in Fig. 5. (Tension Analysis). The choice of casing for the string is made when this curve is plotted.

More detailed comments on the design chart and an example of design (Fig. 11) are in the appendix.

This chart can be simplified to almost any extent desired, although simplification sacrifices flexibility. If only one collapse safety factor is to be used, this factor can be incorporated in the mud weight scale and mud weight can be used directly. If only one safety factor and one mud



GRADE	WGT.	BURST. STR. PSI.
F-25	17	1440
H-40	17	2310
H-40	20	2720
J-55	20	3740
J-55	23	4360
J-55	26	4980
N-80	23	6340
N-80	26	7240
N-80	29	8160
N-80	32	9060
N-80	35	9960
N-80	38	10800

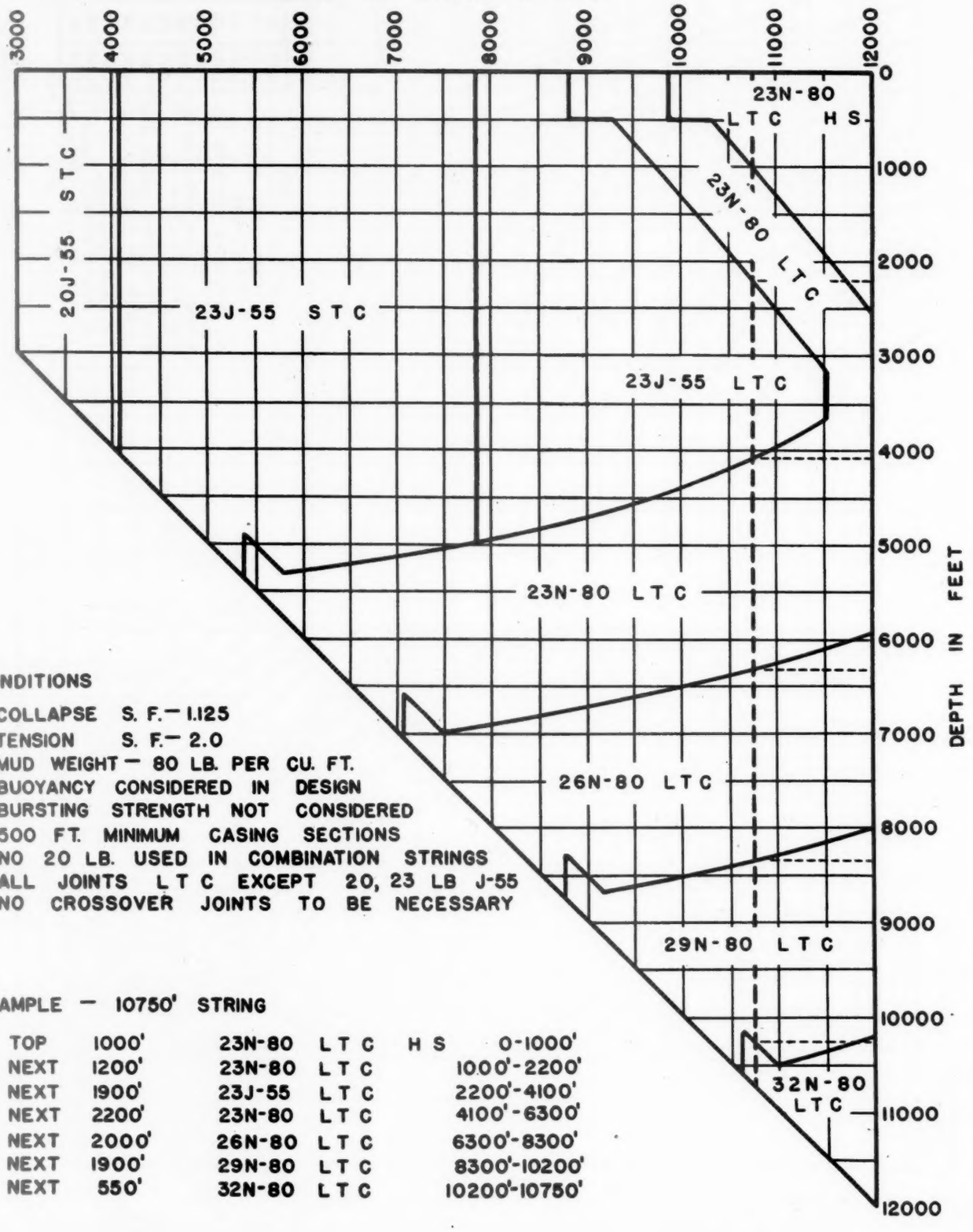
FIG. 9.

FIG. 10.

DESIGN CHART

7" O. D. CASING

DEPTH OF STRING IN FEET



CONDITIONS

COLLAPSE S. F.— 1.125
TENSION S. F.— 2.0
MUD WEIGHT — 80 LB. PER CU. FT.
BUOYANCY CONSIDERED IN DESIGN
BURSTING STRENGTH NOT CONSIDERED
500 FT. MINIMUM CASING SECTIONS
NO 20 LB. USED IN COMBINATION STRINGS
ALL JOINTS L T C EXCEPT 20, 23 LB J-55
NO CROSSOVER JOINTS TO BE NECESSARY

EXAMPLE — 10750' STRING

TOP	1000'	23N-80	L T C	H S	0-1000'
NEXT	1200'	23N-80	L T C		1000'-2200'
NEXT	1900'	23J-55	L T C		2200'-4100'
NEXT	2200'	23N-80	L T C		4100'-6300'
NEXT	2000'	26N-80	L T C		6300'-8300'
NEXT	1900'	29N-80	L T C		8300'-10200'
NEXT	550'	32N-80	L T C		10200'-10750'

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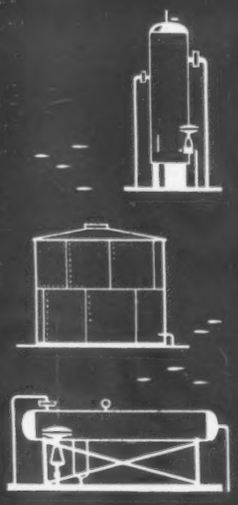

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weight are to be used, the entire left portion of the chart becomes a single vertical line graduated in depths, and the construction of the tension load vs. depth curve is simplified.

With all conditions fixed, the chart will become identical to the type described by Cooley[31, 32] and illustrated by Figure 10. It is very simple to apply, but almost no variations can be made from the assumptions on which the chart is based.

Conclusion

It is probable that less effort has been spent on design of individual casing strings than on other structures of comparable cost and importance. It cannot be said that this results in unsafe casing strings since with present practice there are few failures; so additional effort spent on design can only pay off by reducing cost without increasing the frequency of failures. To accomplish this it will be necessary to apply design principles and practices which recognize as fully as possible the true loading and service conditions. Present knowledge allows much to be done in this direction, but there is continuing need for analysis and tests leading toward a still more complete understanding of the problems of casing string design.

References and Bibliography

1. C. J. Coberly, "Analysis of Casing Stresses and California Casing Practice," API Development and Production Engineering Bulletin No. 204 (1930), p. 22.
2. T. McLean Jasper, "Importance of Compression Yield Strength in Establishing Setting Depths for Casing," API Drilling and Production Practice, 1936, p. 250.
3. W. M. Frame, "Casing Setting Depths are not Assured by Physical Properties of the Steel," API Drilling and Production Practice, 1938, p. 322.
4. C. A. Dunlop, "Trends and Developments in API Pipe Standards," API Drilling and Production Practice, 1938, p. 361.
5. W. C. Shutts, "Recent Developments in Joint Designs of Tubular Goods," API Drilling and Production Practice, 1934, p. 132.
6. W. O. Clinedinst, "A Rational Expression for the Critical Collapsing Pressure of Pipe under External Pressure," API Drilling and Production Practice, 1939, p. 383.
7. J. L. Holmquist and A. Nadai, "A Theoretical and Experimental Approach to the Problem of Collapse and Deep-Well Casing," API Drilling and Production Practice, 1939, p. 392.
8. W. C. Main, "Combining Bending and Hoop Stresses to Determine Collapsing Pressure of Oil-Country Tubular Goods," API Drilling and Production Practice, 1939, p. 421.
9. T. J. Crawford, "Joint and Collapse Strength of API Grades H-40 and J-55 Electrically-welded Casing," API Drilling and Production Practice, 1939, p. 432.
10. B. B. Wescott, C. A. Dunlop and E. N. Kemler, "Setting Depths for Casing," API Drilling and Production Practice, 1940, p. 125.
11. J. B. Graham and E. E. Smith, "Fundamentals of Casing Joint Design and Field Application," AIME Petroleum Development and Technology, 1935, p. 82.
12. E. K. Parks, "Selection of Size of Oil Strings for Wells in California," API Drilling and Production Practice, 1937, p. 41.
13. E. K. Parks, "Effect of Varying Well-Bore Diameters in California Reservoirs," API Drilling and Production Practice, 1939, p. 252.
14. L. C. Uren, J. Domercq, Jr., and J. Mejia, "Influence of Well Diameter Upon the Pressure Gradient and Rate of Flow of Oil Through the Reservoir Rock in the Vicinity of a High-Pressure Flowing Well," AIME Petroleum Development and Technology, 1935, p. 25.
15. I. W. Alcorn, "Slim Hole Drilling on the Gulf Coast," AIME Petroleum Development and Technology, 1941, p. 56.
16. I. W. Alcorn and J. U. Teague, "Reduction of Hole Size in Drilling as Affecting Costs, Completion, and Production Practice," API Drilling and Production Practice, 1941, p. 49.
17. API Bulletin 502, "Performance Properties of Casing and Tubing," Fourth Edition, August 1948.
18. API Bulletin 5A1, "Minimum Performance Properties Proposed API High-Strength Casing Joints," Third Edition, May 1949.
19. J. L. Holmquist, discussion of Westcott, Dunlop and Kemler paper, "Setting Depth for Casing," API Drilling and Production Practice, 1940, p. 190.
20. S. H. Edwards and C. P. Miller, "Discussion on the Effect of Combined Longitudinal Loading and External Pressure on the Strength of Oil Well Casing," API Drilling and Production Practice, 1939, p. 483.
21. S. C. Oliphant and R. F. Farris, "A Study of Some Factors Affecting Gun Perforating," AIME Petroleum Development and Technology, 1947, p. 225.
22. A. Klinkenberg, "The Neutral Zones in Drill Pipe and Casing and Their Signifiance in Relation to Buckling and Collapse." Paper presented at Spring Meeting, Southwestern District, API Division of Production, Beaumont, Texas, March 1951.
23. M. Hawkins and N. Lamont, "The Analysis of Axial Stresses in Drill Stems," API Drilling and Production Practice, 1949, p. 358.
24. J. L. Holmquist, discussion of above paper.
25. J. M. Payne, "Investigation of Equipment and Techniques for 20,000-ft Drilling," API Drilling and Production Practice, 1949, p. 123.
26. J. P. De Hetre, "Casing-Landing Practice," API Drilling and Production Practice, 1946, p. 34.
27. C. H. Oberg and R. W. Masters, "The Determining of Stresses in Oil Well Casing in Place," API Drilling and Production Practice, 1947, p. 257.
28. P. D. Thomas and A. W. Bartok, "Leak Resistance of Casing Joints in Tension," API Drilling and Production Practice, 1941, p. 243.
29. B. E. Curran, "Design of High Strength

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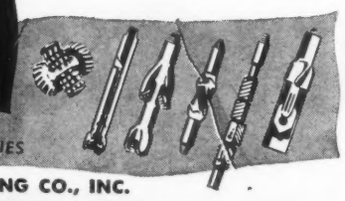

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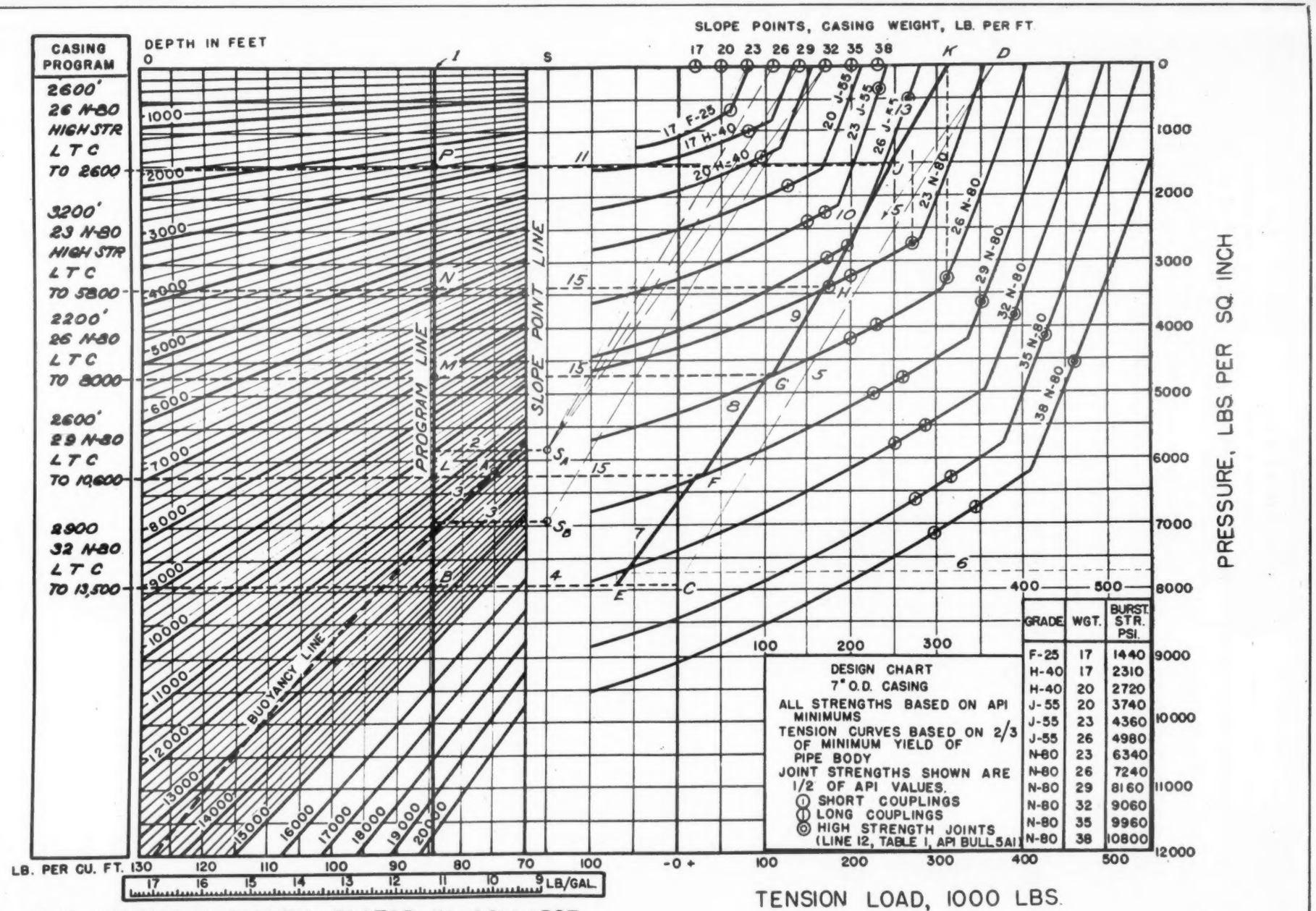
CASING PROGRAM
2600' 26 N-80 HIGH STR LTC TO 2600
3200' 29 N-80 HIGH STR LTC TO 5800
2200' 26 N-80 LTC TO 8000
2600' 29 N-80 LTC TO 10,600
2900 32 N-80 LTC TO 13,500
DEPTH IN FEET
PROGRAM LINE
SLOPE POINT LINE
BUOYANCY LINE
LB. PER CU. FT. 130 120 110 100 90 80 70
17 16 15 14 13 12 11 10 9 LB/GAL.
MUD WEIGHT X SAFETY FACTOR IN COLLAPSE
SLOPE POINTS, CASING WEIGHT, LB. PER FT.
17 20 23 26 29 32 35 38
-0+ 100 200 300 400 500
TENSION LOAD, 1000 LBS.
PRESSURE, LBS. PER SQ. INCH
DESIGN CHART
7" O.D. CASING
ALL STRENGTHS BASED ON API MINIMUMS
TENSION CURVES BASED ON 2/3 OF MINIMUM YIELD OF PIPE BODY
JOINT STRENGTHS SHOWN ARE 1/2 OF API VALUES.
SHORT COUPLINGS
LONG COUPLINGS
HIGH STRENGTH JOINTS (LINE 12, TABLE 1, API BULL 5A1)
17 F-25
17 H-40
20 H-40
20 J-55
23 J-55
26 J-55
23 N-80
26 N-80
29 N-80
32 N-80
35 N-80
38 N-80

GRADE	WGT.	BURST. STR. PSI.
F-25	17	1440
H-40	17	2310
H-40	20	2720
J-55	20	3740
J-55	23	4360
J-55	26	4980
N-80	23	6340
N-80	26	7240
N-80	29	8160
N-80	32	9060
N-80	35	9960
N-80	38	10800

FIG. 11.

Casing String," Conference on Petroleum Mechanical Engineering, ASME, New Orleans, September 1950.
30. Youngstown Sheet and Tube Company, Booklet No. 60 (1950).
31. H. M. Cooley, "Preparation and Use of Casing—Selection Charts," *Oil Weekly*, 113 (10) 33, 36, 58 (1944).
32. H. M. Cooley, "Casing—Selection Charts," *The Petroleum Engineer* 16 (4) 241-51 (1945).
33. Reports of the Committee on Standardization of Oil-Country Tubular Goods, Proceedings of Annual Meetings, API Bulletins 201-235 (1928-1949).
34. J. T. Hayward, "Methods for Determining How Much of a Frozen or Cemented Column of Pipe Is Free," API Drilling and Production Practice, 16 (1935).
35. J. O. Hills, "Design of Casing Programs," API Drilling and Production Practice, 1939, p. 369.
36. W. O. Clinedinst, "Collapse Safety Factors for Tapered Casing Strings," API Drilling and Production Practice, 1945, p. 181.
37. R. J. Kettenburg and Fremont R. Schmieder, "Oil-Well Casing Failures," API Drilling and Production Practice, 1945, p. 185.
38. E. N. Kemler, 'Some Factors Influencing Selection of Factors of Safety in Casing Design," Conference on Petroleum Mechanical Engineering, ASME, Houston, October 1947.
39. W. W. Scott, "Combination Casing Strings," *Drilling* 9 (1) 44-6, 48, 49, 1947); "Selecting Casing Strings," *Drilling* 9 (2) 56, 58, 60, 62 (1947).
40. J. Wais, Jr., "Recent Developments in Casing Standards and Design." API Drilling and Production Practice, 1947, p. 249.
41. H. M. Cooley, "Recent Developments in Recommended Field Practice on Care and Use of Oil-Country Tubular Goods," API Drilling and Production Practice, 1948, p. 229.
42. B. E. Curran, "Combination Casing Strings," *Oil and Gas Journal*, October 14, 1948, p. 80.
43. API Bulletin RP 501, "API Recommended Practice for Care and Use of Casing. Drill Pipe and Tubing," Third Edition, 1949.
44. API Standard 5A, "API Specification for Casing, Tubing and Drill Pipe," 16th Edition, June 1950.
45. B. E. Curran, "Adjusting Casing After Cementing for Stress Control at the Freeze Point," *The Petroleum Engineer's Drilling Digest* (1950), p. 3.

APPENDIX

Construction of Design Chart

A more complete explanation of construction of the design charts shown in Figs. 9 and 11 is available in the informational booklet of a pipe manufacturer.[30] Fig. 9 is essentially the same chart as shown therein with modifications as follows:

1. The curves of collapse strength vs. tension load have been extended into the region of compression.

2. The steep right hand sections of these curves are corrected for 1.125 collapse safety instead of 1.25.

3. One type of high strength joint has been added.

4. API bursting yield strengths have been tabulated at the lower right hand corner of the chart.

5. The line used for origin of slope points is separate from the left hand graph, and is marked with S at its top.

Example of Design

The following example (See Fig. 11) will illustrate the use of this design chart and can serve as general instructions since all designs will follow the same procedure.

Conditions:

Size—7 in. OD, depth—13,500 ft

Collapse loading—Equivalent to 75 lb per cubic foot mud (10 lb per gallon)

Bursting loading—4500 psi to 2000 ft decreased by external pressure of 72 lb per cubic foot mud (.5 lb per foot) from 2000 ft to bottom.

Safety Factors:

Tension—2.00 on API joint strength 1.5 on minimum yield of pipe wall

Collapse—1.125 on API collapse strength except may approach 1.0 at bottom.

Bursting—1.50 on API internal yield pressure.

1. Draw vertical "Program Line" (1) at $(75 \times 1.125) = 84.5$ on mud weight $\times$ safety factor in collapse scale. This line becomes the depth scale for design.

2. Locate air weight slope point S_A by drawing a horizontal line (2) from the 10,000-ft depth point on the program line to the slope point line.

3. Locate buoyancy slope point S_B as follows: From intersection of curved buoyancy line and actual mud weight (A) move parallel to slanting depth lines (3) until program line is reached. Then move horizontally (3) to slope point line at S_B.

4. Draw horizontal line (4) from 13,500 ft (total depth) on program line to zero tension load (Point C). This indicates that 32 lb N-80 probably will be satisfactory at the bottom of the string.

5. Determine compression in pipe at bottom as follows: From C draw a line (5) paralleling S_B-32 to Point D at top of chart. Then from D draw line (5) paralleling S_A-32 to E on Line 4. CE represents the buoyant force on the bottom of the 32 lb pipe, and E is the point from which the design load line starts. This point may be calculated as follows, in which case the "buoyancy line" is not needed.

$$\text{Area of 32 lb pipe} = \frac{32}{3.4}$$

$= 9.4$ sq in.

$$\text{Pressure at 13,500 ft} = \frac{13{,}500(75)(.433)}{62.4} = 7020 \text{ psi}$$

Compression load $= 9.4(7020) =$ 66,000 lb $=$ CE

(Note that the nominal pipe weight is used to compute pipe area, which results effectively in unit tensile stresses being calculated 1.8 per cent low, which is considered negligible.)

6. Check actual collapse safety factor at bottom as follows:

Actual pressure at 13,500 ft $=$ 7020 psi.

Collapse strength of 32 lb N-80 corrected for compression of 66,000 lb is 7700 psi.

See Line 6.

$$\text{Collapse S. F.} = \frac{7700}{7020}$$

$= 1.09$, and is satisfactory.

7. Draw a line (7) through E paralleling S_A-32 and passing through the 29 lb N-80 line a short distance. Starting near this crossing (10,600 ft depth) 29 lb N-80 can be used.

Since there will be a $\frac{32\text{-}29}{3.4} = .88$ sq inch area change with the lighter weight above, the tension load will increase at that point by $.88 \times$ mud pressure at 10,700 ft, and $.88 \times 5500$ $=$ approximately 5000 lb. Locate Point F on the 29 lb N-80 line at 5000

COMMENTS

By VICTOR S. CLAY

Mechanical Engineer, Shell Oil Company, Ventura, California

"The author is to be complimented on his analysis of the problems encountered in designing casing. The approach used is good. All the conditions encountered during the life of a string of casing are considered and the possibilities of failure are carefully examined, yet the method of design suggested is sufficiently simple to use as to be practical.

"Considering the report, one finds the force of buoyancy included in collapse strength analyses. This is new, but proper. Unless the buoyant force is recognized in casing design, unnecessarily strong casing is put at the bottom of the casing string where additional collapse strength is least needed.

"The design chart recommended in the report, Fig. 9, is conservative in collapse design in that the additional buoyant force caused by the extra weight of the fluid cement is not taken into consideration.

"Regarding the design of casing in tension, the overpull method seems more logical than a design based only on a standard safety factor and either the yield strength of the pipe or the joint. To illustrate: A 1.5 safety factor based on the minimum yield of 7", N-80, 26-pound, T. & C. allows 153,000 pounds overpull, while the same safety factor on 7", N-80, 32-pound E. L. allows 246,000 pounds overpull. In view of this, a design based on overpull, with consideration being given to the well condition, clearances and depth, appears to be preferred."

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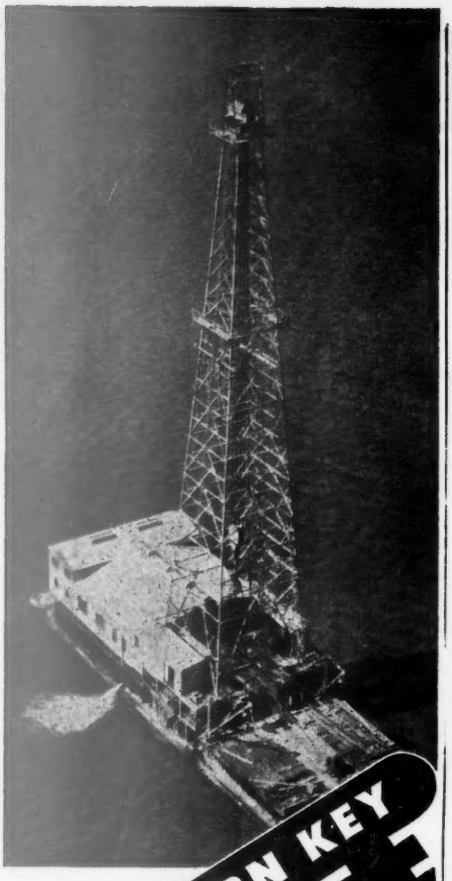

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lb tension load to the right of the line (7) just drawn upward from E.

8. From F draw a line paralleling S_A-29 and proceed as in Step 7, establishing Point G above which 26 lb N-80 can be used.

9. From G proceed similarly, establishing Point H above which 23 lb N-80 can be used.

10. From H draw a line (10) upward, paralleling S_A-23.

11. At this time the factors of bursting and tension must be considered. From tabulation at the lower right, API bursting yield strength of 23 lb N-80 is 6340 psi, and allowable working pressure with 1.5 S. F. is $\frac{6340}{1.5} = 4200$ psi. From the bursting load assumption, 4200 psi differential pressure will occur at 2600-ft depth.

Draw horizontal line (11) from 2600 ft depth on program line to intersect line (10) coming up from H. Above this point (J), 26 lb N-80 must be used to meet the bursting requirement. From the allowable joint loads shown on the 23 lb N-80 line, it can be seen that both long and short regular API joints have allowable loads less than the 240,000 lb load at Point J but the high strength 23 lb N-80 joint at 270,000 lb allowable load will be satisfactory.

12. At J make tension correction for area change, which will be negative since the higher weight is on top.

$$\frac{.88 \times 2600 \times 75 \times .433}{62.4} = 1200 \text{ lb},$$

reduction in tension load.

13. From the corrected Point J draw a line (13) upward paralleling S_A-26 to intersect the top of the chart at K.

14. The tension load (at Point K) is 311,000 lb. The 26 lb N-80 LT&C high strength joint plotted has an allowable load of 312,000 lb and, therefore, is satisfactory.

15. Draw horizontal lines (15) from F, G, and H to program line.

16. At the points of intersection L, M, N, P of lines 15 and 11 with the program line, read the depths of the changeover points.

17. Record these depths in the casing program column at the left of the chart, together with the length and specification of each section.

The program, assuming Long Threaded and Coupled joints throughout, is then as follows:

It happens that in this string the overpull necessary to stress the three top sections to their minimum ultimate joint strength is very nearly the same in spite of the 2.26 and 2.88 minimum safety factors in the lower two of these sections.

Landing Practice. De Hetre's equations for changes of load due to temperature and pressure changes in casing are as follows:

1. Temperature change

$$P = 58.2\ W\Delta T$$

where

P = Change in load at landing head (pounds)
W = Nominal pipe weight (pounds per foot)
ΔT = Average temperature change of free casing (degrees F)

A temperature drop results in an increased load, while a temperature rise results in a decreased load.

2. Pressure change

$$P = 0.0434\ W\Delta p \frac{D}{t}$$

where

P = Change in load at landing head (pounds)
W = Nominal pipe weight (pounds per foot)
Δp = Average net pressure change in free pipe (psi)
D = Casing outside diameter (inches)
t = Casing wall thickness (inches)

When the net pressure change is an internal increase, the change of load at the landing head will be an increase. When the net pressure change is an internal decrease, the change of load at the landing head will be a decrease.

Bursting Pressures. The following approximate formula can be used to calculate the maximum surface pressure in a well full of dry gas at a known or assumed bottom hole pressure.

where

$$P_S = \frac{P_B}{1 + .02D}$$

where

P_S = Pressure at surface, lb per sq ft
P_B = Bottom hole pressure, lb per sq in.
D = Depth, thousands of feet.

* * *

Interval	Length	Size	Weight	Grade	Joint	Safety factor C	Safety factor T	Safety factor B
0–2600	2600	7 in.	26 lb	N-80	High strength	High	2.03	1.60
2600–5800	3200	7 in.	23 lb	N-80	High strength	1.125	2.26	1.50
5800–8200	2200	7 in.	26 lb	N-80	Long T&C	1.125	2.88	High
8200–10600	2600	7 in.	29 lb	N-80	Long T&C	1.125	High	High
10600–13500	2900	7 in.	32 lb	N-80	Long T&C	1.09	High	High

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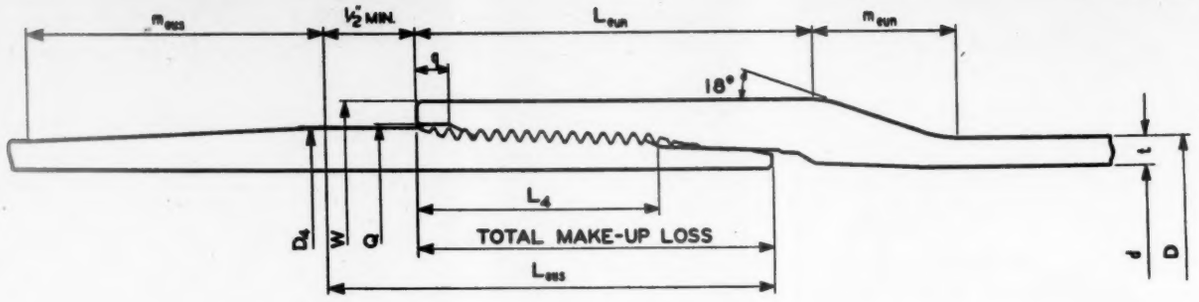


JOINT ENGAGEMENT - POWER TIGHT

PIPE							JOINTS										TEST PRESSURE			
	WEIGHT PER FOOT						MALE END					FEMALE END						SUPPLEMENTARY *		
SIZE O.D. D	NOMINAL	CALCULATED PLAIN END	CALCULATED UPSET AND THREADED	WALL t	I.D. d	DRIFT DIAMETER	O.D. TOL. + .062 − 0 D_4	LENGTH MINIMUM L_{ms5}	UPSET TAPERED LENGTH APPROX. m_{ms5}	THREAD LENGTH L_4	MAKE-UP LOSS TOL. ± .031	O.D. TOL. ± 1/32 W	LENGTH TOL. + 1/16 − 1/8 L_{sun}	UPSET TAPERED LENGTH APPROX. m_{sun}	RECESS DIAMETER TOL. + .007 − 0 Q	RECESS DEPTH TOL. + 1/16 − 0 q	STANDARD (API) ALL GRADES	J-55	N-80	
Inches	Pounds			Inches			Inches					Inches					Pounds per Square Inch			
2 3/8	4.70	4.43	4.55	.190	1.995	1.901	2.594	3.380	2 1/2	1.770	2.911	3	3 9/16	1 7/16	2.656	1/4	3000	7000	10200	
2 7/8	6.50	6.16	6.27	.217	2.441	2.347	3.094	3.567	2 1/2	1.957	3.098	3 17/32	3 9/16	1 7/16	3.156	1/4	3000	6600	9700	

FIG. 2.

Development of the Spangseal Tubing Joint†

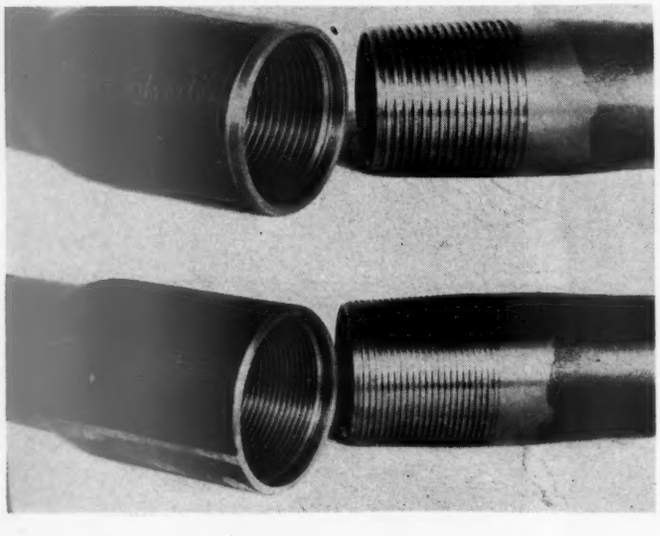
J. L. HOLMQUIST*

THE development of a tubing joint with improved leak resistance was undertaken several years ago in response to reports that leakage was frequently encountered with the API tubing joint. The reports indicated that the production of a more leak resistant tubing joint that could be manufactured at a moderate increase in cost would meet a definite need. The Spangseal joint represents an attempt to meet this need.

The first design investigated as a possible improvement over the API joint was an integral joint provided with close fitting Acme type threads. Some joints of this kind were made for testing purposes, particularly leakage tests. Two thread pitches were investigated, 6 and 8 threads per inch. Fig. 1 shows a specimen of each. The

†Presented at the midyear Standardization Conference of the Division of Production of the American Petroleum Institute, Denver, Colorado, May 28-June 1.

*Director of research, The National Supply Company, Spang-Chalfant Division, Ambridge, Pennsylvania.



← FIG. 1.

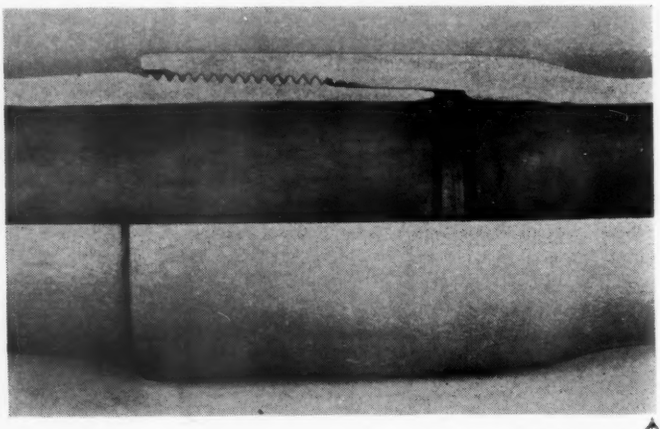


FIG. 2A. ↑

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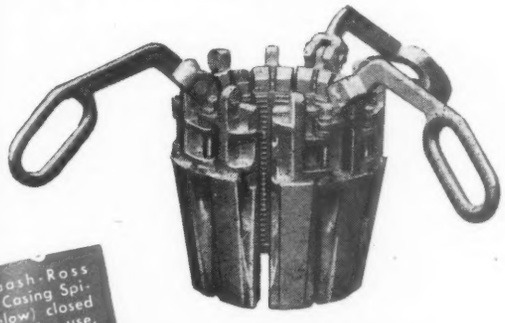


The Baash-Ross Hinged Casing Spider (below) closed and ready for use. Split Spider Bushings (right) lock in place to adapt Spider for smaller pipe sizes. Baash-Ross Type "UC" Casing Slips (top) are recommended for handling casing 7⅝" O.D. and larger. (For smaller pipe use Baash-Ross "DU" or "2MB" Rotary Slips.)

MAXIMUM CASING ADAPTABILITY

Wide-range installation adaptability is only *one* of the features in the Baash-Ross Hinged Casing Spider, for it is equally adaptable to handling a complete range of pipe sizes 18⅝" O.D. and smaller.

The Spider is made in *four* basic sizes... 18⅝", 16", 13⅜" and 10¾"... and each basic size will not only handle the diameter of casing corresponding to its size designation, but can be readily adapted to handle any smaller size of casing by simply inserting removable Spider Bushings.

These Spider Bushings are split and are retained solidly in place whether the Spider is open or closed. And regardless of the basic size, each Casing Spider can be bushed down, if desired, to the bore and taper of a standard rotary master bushing, thus permitting the use of standard rotary slips for handling small casing as well as any other pipe sizes that can be supported in regular rotary slips.

A Universal Casing Spider that meets every Casing Handling Requirement!

The BAASH-ROSS HINGED CASING SPIDER

THERE HAS long been a need for a lightweight heavy-duty casing spider universally adaptable to practically *any* pipe-handling requirement. And here it is—The Baash-Ross Hinged Casing Spider. Though light in weight, it will safely support the longest and heaviest casing strings. And note its wide-range adaptability...

- You can place it directly on top of any type or size rotary table for supporting casing strings too large to be run through standard rotary master bushings. No need to remove the rotary table, no wasted time disconnecting the table drive and then reinstalling and realigning the table hook-up.
- Or, if preferred, you can use the Hinged Casing Spider on a platform that replaces the rotary machine.
- Or on workover, salvage and other operations where no table is installed, the Hinged Spider can be supported directly on cribbing, thus providing a quick and convenient method of handling casing and other pipe.

HINGED FOR QUICK EASY INSTALLATION

By simply pulling a pin, the Baash-Ross Hinged Casing Spider can be quickly opened, thus permitting its installation without need for stripping the unit over any pipe that may be hanging in the well. The double pin arrangement not only permits the Spider to be opened on either side, but also permits the Spider to be separated into two parts for maximum ease in handling and transporting.

Hinge pins as well as handles are streamlined into the body contour, while a generous slip-supporting platform and safety grid, low overall height and wide solid base all contribute to maximum safety and crew convenience.

Get full details on this new Baash-Ross Hinged Casing Spider from your nearest Baash-Ross representative—or write direct for additional data.

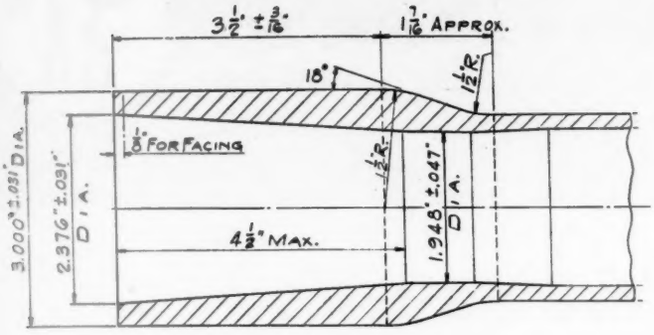


FIG. 3. Box upset, 2⅜-in. tubing.

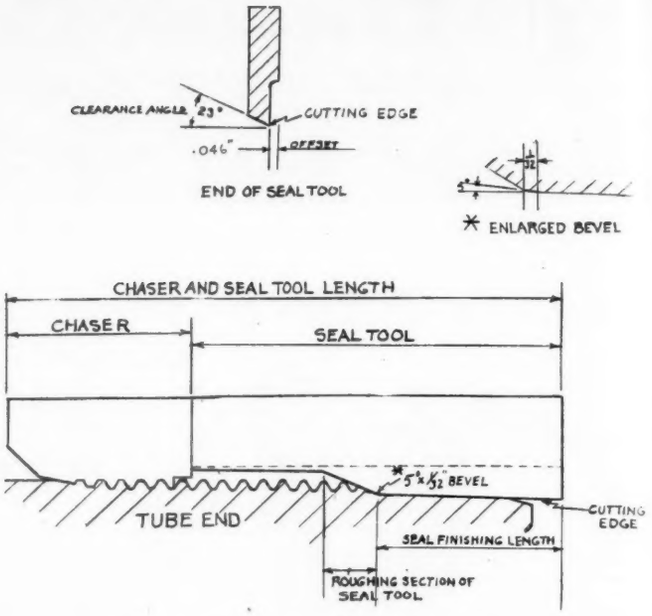


FIG. 4. Chaser and seal tool, finish position on pipe end.

leakage tests were considered unpromising, however, so this line of development was dropped. The solution of the leakage problem by the use of special thread profiles had not been viewed with any great optimism anyhow, so attention was turned to other means.

A casing joint containing a pressure sealing element independent of the threads had been thoroughly tested over a period of years and was known to be highly leak resistant. The pressure sealing element consisted of smoothly machined, substantially conical, metal surfaces that are brought into contact under definite radial pressure when the joint is made-up. The original development work on this joint had demonstrated that the best location for the sealing surfaces was at the small end of the pin thread and the corresponding location in the box member. It was decided to investigate a tubing joint of the integral type provided with such sealing surfaces.

As stated in the opening remarks the problem undertaken was twofold: 1) to make a more leak resistant joint and 2) to make it at a moderate cost. Accordingly, in the design considerations the manufacturing procedures were studied simultaneously. The joint design arrived at on the basis of the above considerations is shown in Fig. 2. It is the integral type. The threads are identical with API in form, pitch. pitch diameter, and taper. A conical sealing surface is positioned at the small end of the pin thread and the corresponding location in the box member. Fig. 2A shows an actual joint in longitudinal section.

It actually turned out that the development of the manufacturing procedures required the greater part of the development work. A full account would be outside the scope of this discussion; however, two points will be mentioned in illustration.

One of these is the upsetting of the ends of the tubing. Upsetting is a hot forging operation in which the ends of the pipe are heated to a forging temperature prior to insertion in the upsetting machine. In order to keep the cost down, it was desired to go through the operations of heating the pipe ends and passing them through the upsetting machine only once. In the shop vernacular the upsets are made in one heat.

To make the pin end upset in one heat presented no difficulties. The API tubing upset can be and at times has been used. However, an upset slightly longer than the API upset is preferred; mostly for the sake of appearance.

The box end upset is a more difficult operation. It was desired to make the outside diameter large enough so that the tubing could be handled by elevators seating on an 18 deg taper shoulder between the upset OD and the pipe OD, thus eliminating the use of lifting plugs. To accommodate the combined length of threads and seal a fairly long upset is required. The resulting upset shown in Fig. 3, represents, in our judgment, about the maximum that can be produced in a one heat operation.

The other illustrative point is the machining of the pin and seal. For economy it was desired to combine the machining of the seal with the threading operation. The procedure adopted consisted of providing seal cutting tools in the die containing the thread chasers. The arrangement is shown diagrammatically in Fig. 4. One of the die blocks with the chaser and seal cutting tool clamped in position is shown in Fig. 5. The chaser cuts a thread the full distance from the end of the pipe to the last scratch but the seal cutting tool following behind it cuts off, on what becomes the seal surface, the threads initially formed there by the chaser.

In reducing the above plan to practice, difficulty was encountered in obtaining a finish on the seal smooth

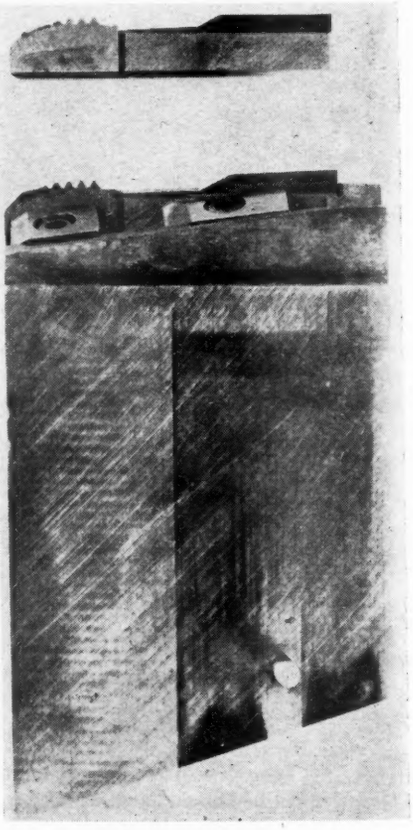
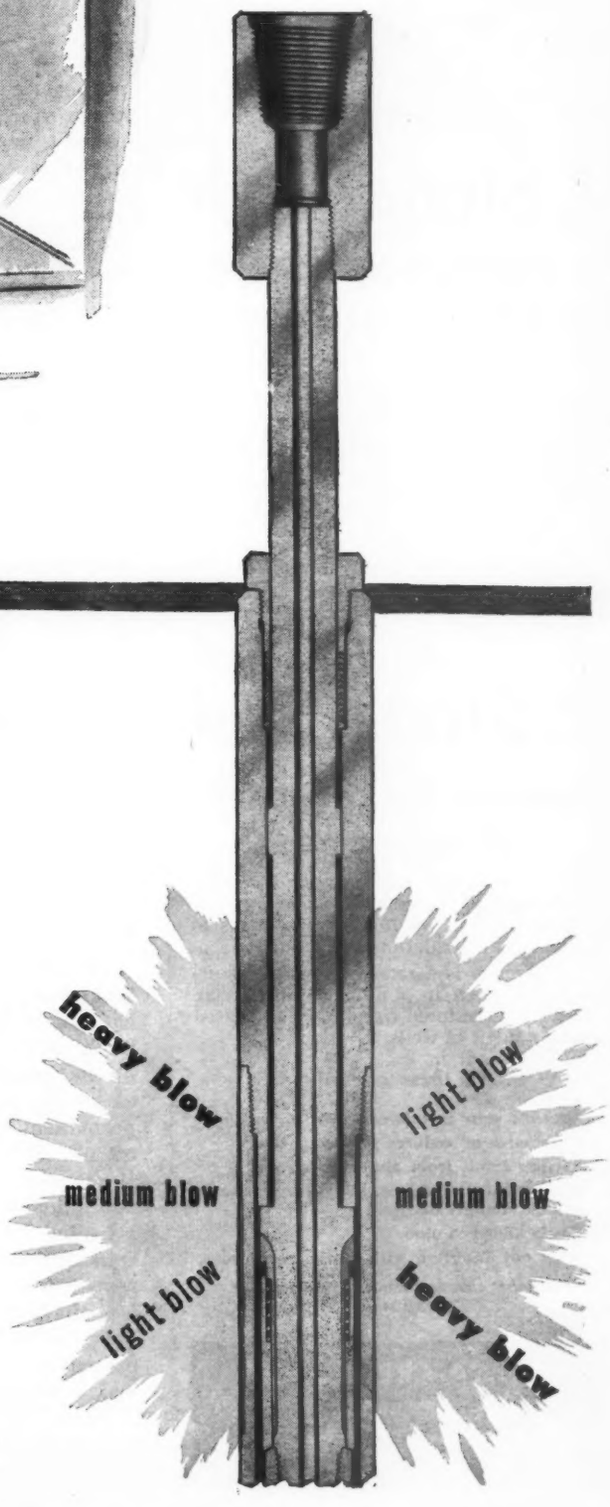


FIG. 5.

The right jar for the job at hand

Jarring Jerry



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enough for sealing purposes. Initially the taper of the seal was made the same as the taper of the threads, which is 0.0625 in. per inch on diameter. The solution to this difficulty was found to be to make the taper of the seal slightly steeper than the taper of the thread. The taper used on the seal is 0.070 in. per inch on diameter. When the taper of the seal is steeper than the taper of the thread, the long trailing edge of the seal cutting tool takes a light cut off the surface left by the roughing section of the tool. It is this light cut that produces the smooth surface on the seal.

When the manufacturing procedure had been developed to the point where joints of satisfactory quality for test purposes could be produced, a considerable number were made and subjected to leakage tests. Some 80 joints were tested with nitrogen gas at pressures up to a maximum of 6500 psi. The tests were so conducted that only the seal was resisting leakage and the threads were not contributing to leakage resistance. The purpose of the tests was to determine whether the seals made according to the planned manufacturing procedure would be adequately leak resistant. No leakage occurred on any joint complying with the inspection standards.

The make-up characteristics of the joint are similar to those of the API joint. It is designed for a nominal make-up of two turns beyond hand tight, which positions the last scratch on the pin at the face of the box. The thread lengths are proportioned to permit approximately two turns additional make-up before interference occurs on the roots of the imperfect threads.

The seal diameters are maintained so that hand-tight contact of the seal surfaces occurs from zero to one-half turn before hand-tight engagement of the threads. The purpose is to insure a leak tight joint even though the thread make-up is on the low side.

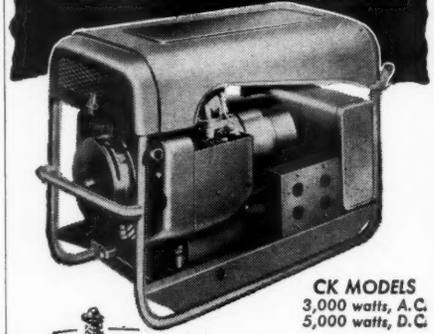
When the threads are made-up two turns beyond hand-tight, the theoretical seal interference is approximately 0.020 in. A seal of the diameter used on the Spangseal joint will not deform elastically this amount and there is a permanent reduction in diameter of the pin seal when the joint is made-up. If necessary to break-out and make-up again, loss of interference can be compensated for by making-up further on subsequent makeups. If subjected to repeated make-ups and the last one is less than the previous one, however, the possibility exists that there will be no seal interference at all and the only leak resistance is that which is provided by the threads. It is for this reason particularly that the Spangseal joint is not recommended for working strings that are to be subsequently set as flow strings. Its intended use is as flow strings only.

Trial Strings Made

In consequence of its satisfactory performance on leakage tests at the laboratory, several trial strings were made. The first two strings were run in the Gwinville, Mississippi, field. They were set to approximately 7800 ft in gas condensate wells with a top hole pressure of 2500 psi. Another trial string was set in the Iowa, Louisiana, field to approximately 9900 ft. Top hole pressure in excess of 6000 psi has been observed on this well. These strings were run with elevators lifting on the box end 18 deg shoulder, as have all others run so far to the best of our knowledge. Lifting plugs are not required although the elevator used should be in good repair. The performance of the trial strings was observed for some time and all reports to date indicate that leakage resistance is entirely satisfactory.

Although considerable footage of tubing equipped with the Spangseal joint has been shipped, more specific evaluation of the merits of the joint can be made when time and quantity bring to light every possible operating condition. * * *

ONAN *Oilfield*
Electric Plants



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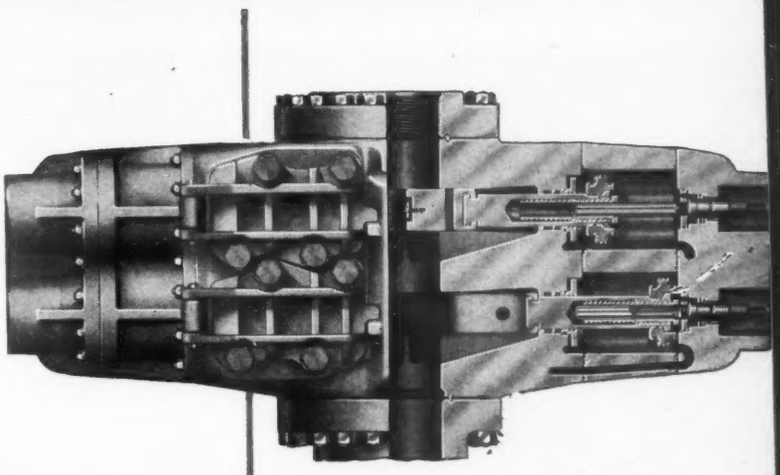
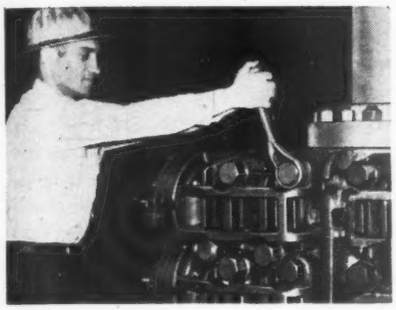
Only 4 easy steps to change rams

in the NEW SHAFFER HYDRAULIC CELLAR CONTROL GATES

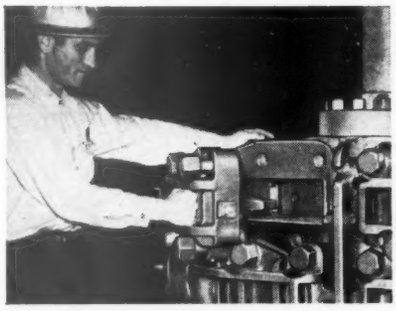


Note in this sectional view how two separate ram compartments are unitized into one compact body in the Shaffer Hydraulic Cellar Control Gate. Also note the steeply-sloped self-draining bottoms of the ram compartments . . . the direct hydraulic drive . . . and the completely enclosed design with no exterior operating parts to become jammed, damaged or corroded.



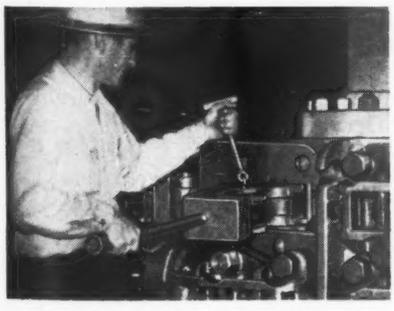
1 Unbolt two doors

in the side of the Gate. You don't even have to remove the bolts—they remain in the doors where they can't become lost.



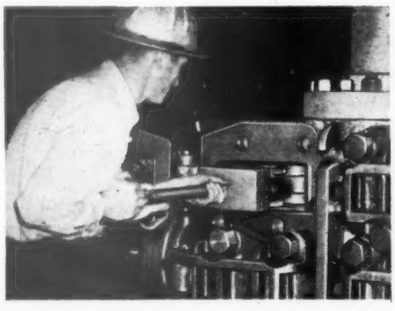
2 Swing the doors open

and pull out the ram assembly. There is nothing to loosen, unlock or disengage. The complete ram assembly slides right out.



3 Lift the rams

from the Gate and simply replace the ram blocks and rubbers with others of the desired size—a quick, simple operation.



4 Slide the ram assembly

back into the Gate, close and bolt the doors. Closing the doors automatically aligns the ram assemblies within the Gate.

With the Shaffer Hydraulic Cellar Control Gate you can make ram changes faster and simpler than in *any other* cellar control gate. And—equally important—you can make a complete ram change *whether the pipe is in or out of the hole!*

And remember this—unusual speed and simplicity of changing rams is only one of *many* vitally important advantages Shaffer engineers—pioneers in the development of high-pressure control equipment—have incorporated into Shaffer Hydraulic Cellar Control Gates. Check over the additional features outlined at right, and then get the *complete* story on these advanced Gates before you buy *any* cellar control gate equipment. No other equipment provides so much protection—in so small a space—with so many far-reaching advancements!

CHECK OVER THESE UNIQUE FEATURES, TOO!

- **UNUSUAL COMPACTNESS:** Although *two* separate ram compartments are unitized into *one* body, the overall height of the Gate, including both compartments, is only 30" in sizes as large as 13⅜" (12" Series 900). Smaller sizes are even more compact!
- **QUICK DRAINING BODY:** Note in sectional view above how the rams travel on high narrow guide ribs above the steeply-sloped bottoms of the ram compartments. Mud and sand quickly drain back into the well—no detrimental accumulations to interfere with free ram travel!
- **DIRECT HYDRAULIC DRIVE:** Also note in the view above how the hydraulic operating cylinders are directly *behind* the rams for positive action, maximum simplicity, greatest safety. There are no secondary connections between hydraulic cylinders and rams!
- **COMPLETELY ENCLOSED DESIGN:** All moving parts—even the piston rod ram shafts—are completely enclosed within the body of the Gate. There is nothing to become wedged or damaged by objects falling into the cellar—nothing to become corroded by chemical and mud drippings. Even the locking shaft is non-rising—fully protected!

And there are still other important features—all combining to make the Shaffer Hydraulic Cellar Control Gate the most advanced hydraulic gate available today. Get full details from your Shaffer representative—or write direct.

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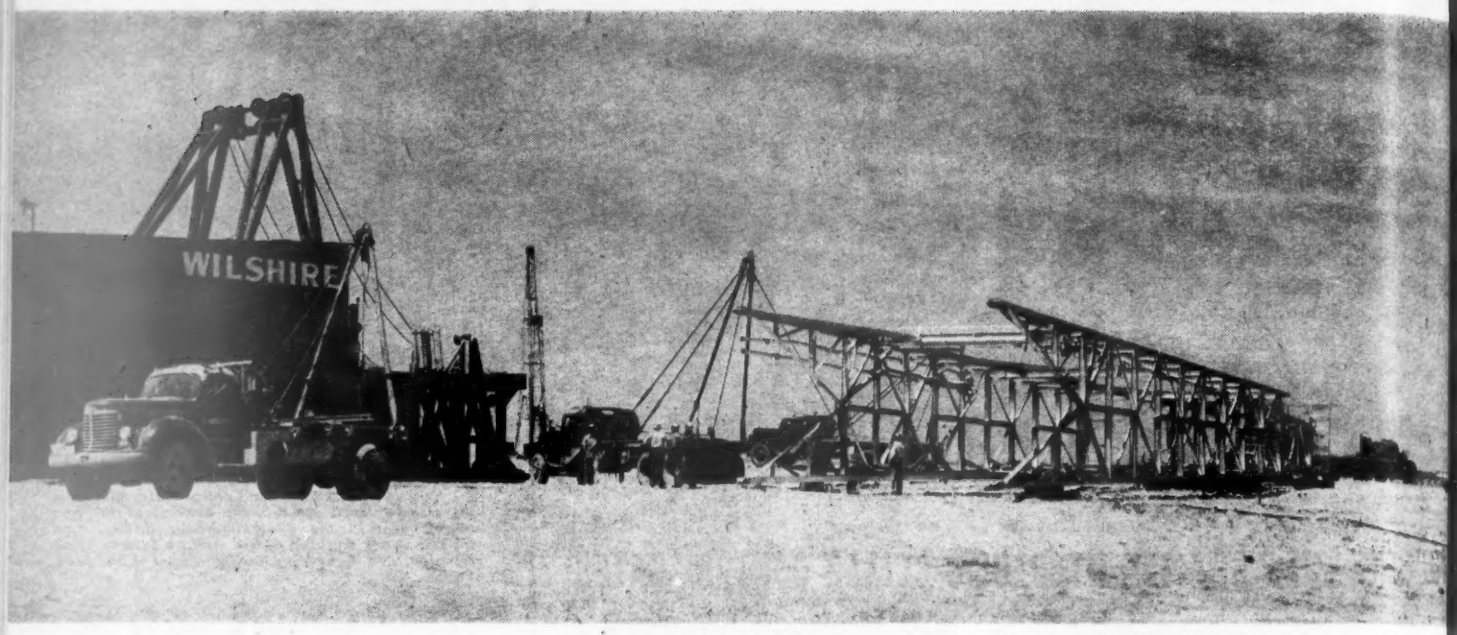


Prior to total assembly on arrival in the field, this shows preparations for putting the derrick on the sub-base of the National 125.

West Texas Preview of Tomorrow's Oil Well Rigs and Drilling Methods

RICHARD SNEDDON*

ANYONE who is interested in the drilling equipment and techniques of the future ought to take a look at what is happening on the McElroy Ranch in Upton County, West Texas. Here, under the direction of Maurice A. Machris, executive vice president of Wilshire Oil Company, the engineering genius of Frank B. Lake, vice president in charge of Texas operations, is fashioning modernistic tools and techniques that seem to be ahead of their time. In brief, Lake and his aides have skipped all the intermediate steps in unitization and have come up with the complete thing; have accomplished what looks very much like the absolute in rig mobility, and to top it all off have introduced a totally new procedural routine that is vastly speedier and more economical than anything hitherto attempted.

The possible ramifications of the story are endless but the immediate pertinent facts are these: Wilshire Oil Company brought out from California a large, deep-drilling rig, with a conventional 156-ft derrick on a 36-ft base. With this rig, which had no unitization whatever, the company drilled its discovery well in the McElroy Ranch field. The well was drilled to 13,977 ft and did not produce from the Ellenburger, as had been expected, but showed some indication of production in the Pennsylvanian and was finally completed in the Permian.

This was all very interesting and exciting in its place but there was another something that excited the operator in an altogether different way. That was the terrific cost of moving in and setting up a deep-drilling, nonunitized rig. Actually, trucking in all the component parts and assembling them for the drilling operation cost somewhere between $15,000 and $17,000, which Maurice Machris thought was neither nice nor necessary. In consequence, he at once organized an intensive study of unitization with the avowed purpose of cutting "completion to spud" moving costs to a reasonable figure. Frank Lake, with a wealth of experience in all phases of drilling and production, was ideally equipped to take care of such an assignment and the signal success of his subsequent efforts is proof enough that he was a wise choice.

The big barge-type rig used for drilling of the Gulf Coast was selected by Lake because of its remarkable stability and balance, and because it seems to have many of the qualities that are required in a portable deep-drilling outfit. The derricks are so constructed as to be able to stand tilting to very acute angles without showing any tendency to topple over. In-

*Pacific Coast Editor.

EXCLUSIVE

A color motion picture has been made of the unusual operations described in this article. It will be shown in a number of West Texas theaters, and will also be available for showings to higher grade schools, colleges, business clubs, civic groups and, indeed, wherever it would seem that it might help to enlighten the public as to the ways of the petroleum industry.

deed, the entire units are rugged, strong, and capable of withstanding very rigorous handling. Careful examination of these sturdy units suggested the idea of *land barges* on which the drilling rigs and all their appurtenances might be transported from place to place in a single package.

With this in view, a second outfit was purchased. Its principal feature was a double bulge Emsco-type derrick with a working load of a million pounds and a 10-ft sub-base. The sub-base was completely redesigned to take the National 125 outfit, powered with three Le Roi B-12's, driven through a compound gear, especially developed for the rig. Also included were two Ideal pumps—a C-350 and a C-250, and two steel mudpits. The left side of the sub-base carries change rooms and two separate tool rooms. Of the latter, the one towards the rear is a storage compartment for engine and pump parts, such as liners, valves, etc., while the front chamber is a repository for tongs, slips, elevators, chains, belts, and equipment that would normally be on the derrick floor during operations.

The other side of the sub-base carries the mud manifold, a gas separator, a purifier for desulfurizing natural gas when it is used as fuel, water softeners for the radiator water, and a mud laboratory. Actually, the sub-base consists of two parallel sections, approximately 60 ft long and 8 ft wide, joined together by three 8-ft by 12-ft spacers. The front section holds the rotary table and blowout prevention equipment. On the middle and back sections are two 200-bbl water tanks (for rig wash-down and radiator water, etc.). Two steel mud tanks with shaker screens form a separate package.

Frank W. Lake is vice president of Wilshire Oil Company, Inc. in charge of Texas operations.

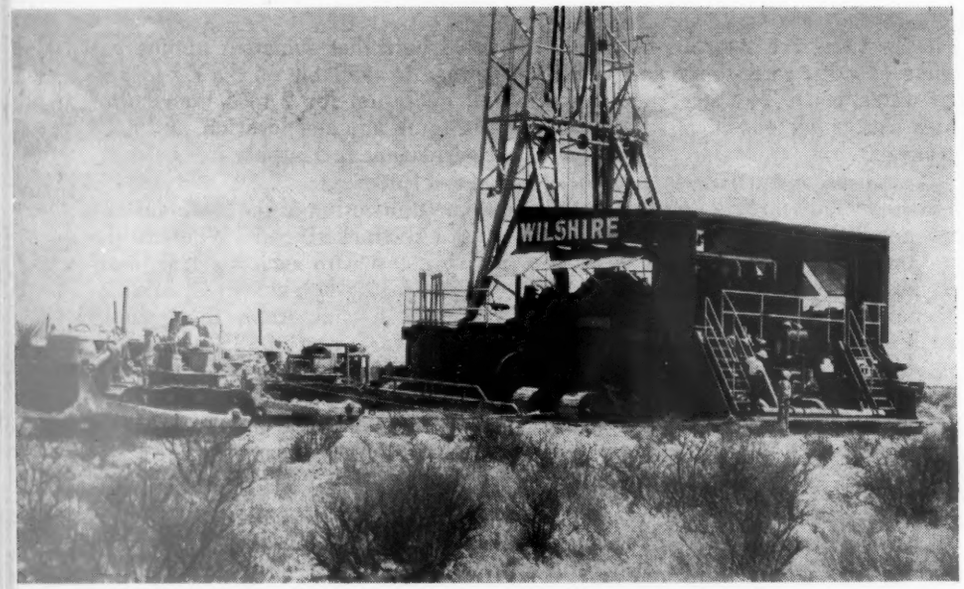
Maurice A. Machris, executive vice president of Wilshire, under whose direction the program was developed.

It is to be noted that suction lines, flow lines, mud-mixing lines, and other lines that couple pumps, mud pits, and the main rig together are all either flexible hoses or combinations of steel and flexible hose. In any case everything can be tied together with regular hammer-on connections or Dresser couplings without the necessity of tedious alignment or leveling to perfect exactitude, and without any loss of time. Perhaps it should also be noted here that sufficient butane gas storage is available on the rig to permit operation for 2 to 4 hours after setting up at a new location, and until a permanent fuel supply has been arranged for.

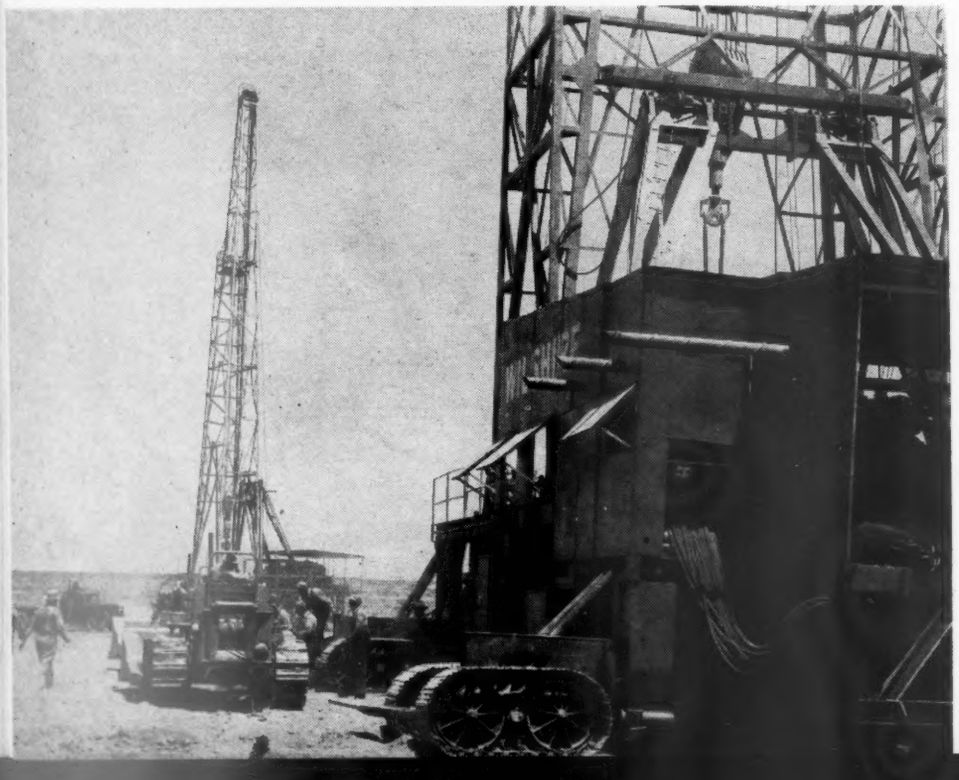
The unitization of the National 125 was a distinct success. Whereas the moving cost with such a rig ordinarily was in the neighborhood of $15,000, now a comparable move could be made for a cost of $2500. Another outstanding advantage was that the entire rig could be moved in 6 to 7 hours as compared with 10 or 12 days formerly. In the meantime, also, the moving process itself had become a

Matting boards are laid down for either of the big rigs. The small rig sits on the base of the mud tanks.

Another shot of a tractor in action. The drivers are extremely expert at moving into the exact spot required either for pushing in the locking beams or adjusting the Athey wagons.



View from the opposite side of the small rig, showing the C-150 pump, change rooms, etc. This also shows the tractors yoked to the Athey wagons.



Here the Athey wagons have been set under the beams on the National 100 and, will be ready to move as soon as the yoke has been attached to the wagon tongues.

neatly integrated system that dovetailed right in with operations and posed no problem to the drilling crews. But more of that later! Here, suffice it to say, the whole venture was so successful that a second unit was revamped in almost exactly the same manner. This was a National 100, powered with three 6G5-10 Superior gas engines. It employed the same jack knife derrick and sub-base, and the adaptation of the latter was patterned along the same lines as the first one.

At this stage, it is perhaps apropos to mention briefly the method of transportation. First, it should be noted that for local movements, the two large unitized rigs already referred to can each be handled in 4 packages, consisting of 2 mud pumps, 2 tanks, and the butane tank, which are hauled separately by truck. The rest of the rig is moved by Athey wagons. The smaller packages are carried on trucks equipped with winches in a rather unusual manner. The unit, whatever it may be, is pulled up over the back of the truck bed with a winch line to a sort of teeter-totter position. Here it remains balanced, half in and half out of the truck, while it is carried speedily to the new location. On arrival there the driver merely lowers the rear end of his load into position, then drives forward, allowing the piece to sit down in its proper place. It is all done by one man without any strenuous effort on his part and there is no bumping or grinding. The load settles into its allotted space as gently as if it were being laid there by some kindly dispositioned Samson.

The main part of the load, consisting of the standing derrick, sub-base, and everything that is not separately handled in packages as already detailed is moved by means of Athey wagons and tractors so expeditiously and efficiently as to make much less complicated moves look cumbersome. The crossbeams that tie the sub-structure together are elevated by hydraulic jacks just high enough to let the Athey wagons slide underneath. Then they are lowered on to the wagon beds, a wide yoke is pinned to the Athey tongues, a tractor or two hitch on to the yoke, and off they go across country.

It is as simple as that and is done almost as quickly as it takes to de-

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After many years of painstaking evaluation and study, improved techniques of Radioactivity Well Logging now permit the quantitative interpretation of fluid filled porosity in many oil areas. It is now possible to estimate the amount of fluid filled porosity of certain formations traversed by the well bore to a degree of accuracy sufficient for commercial purposes. The value of such interpretation, as a guide to well completion and production, is too self-evident to require discussion. Limited at the moment to certain formations, the scope of this service is being extended, as rapidly as possible, to other producing areas where the formation responses will permit quantitative interpretation to be made.

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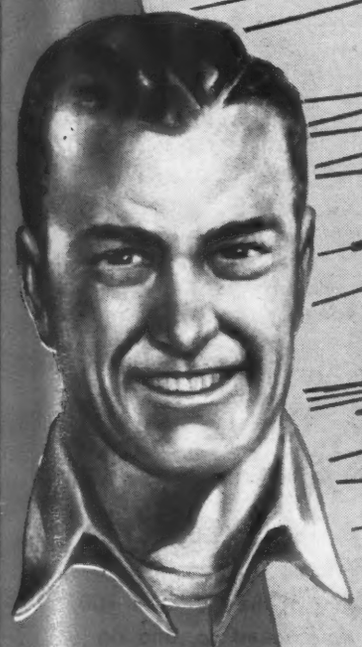

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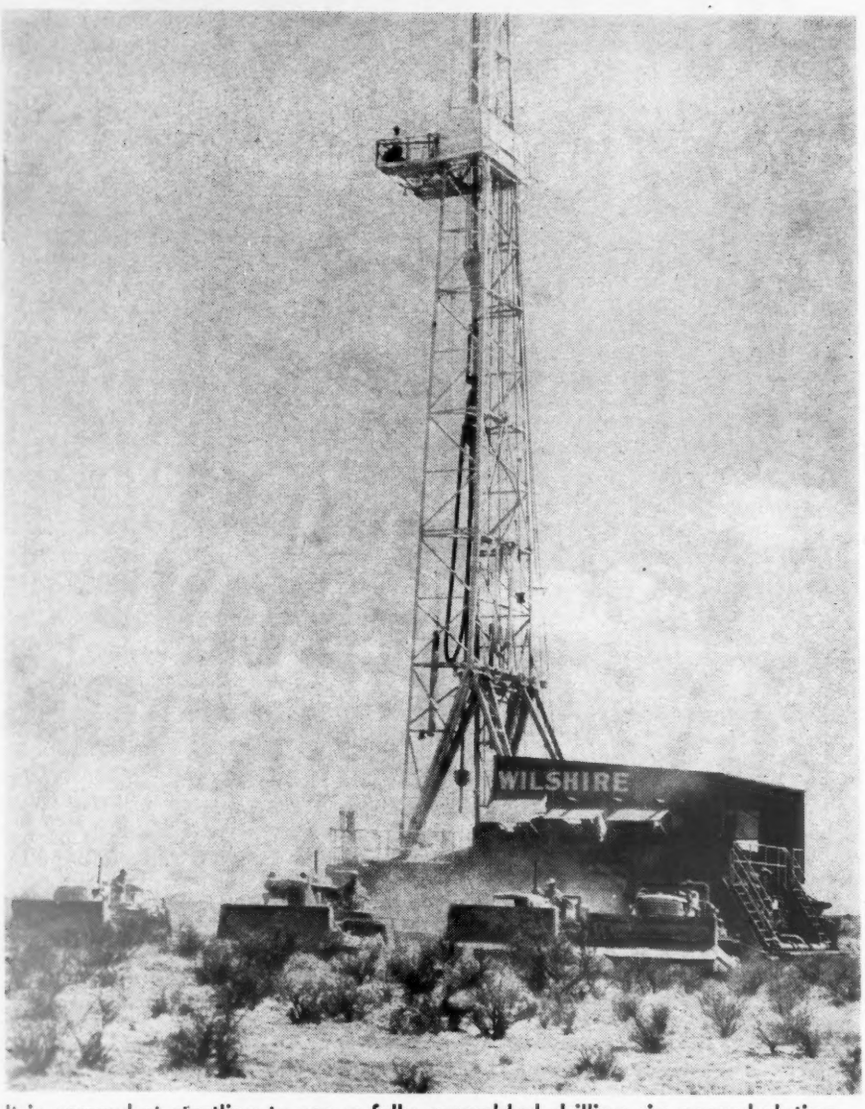
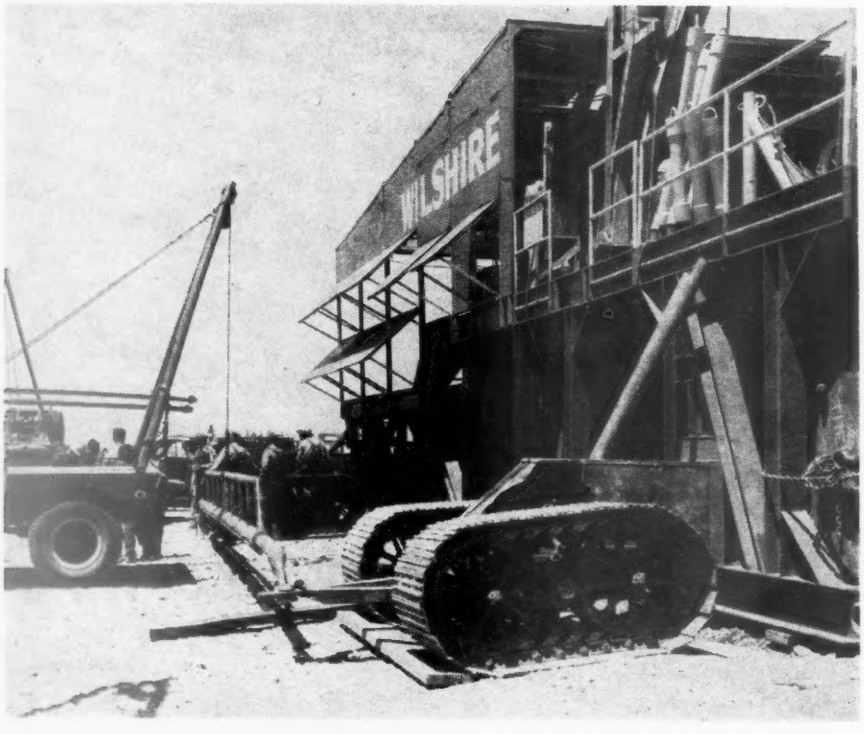


It is somewhat startling to see a fully assembled drilling rig perambulating across the country. This is the National 50 on the move.



A closer shot of the National 100, showing yoke hoked up, and rig all prepared to go.

scribe the process here. Rumbaugh, the transportation specialists, in concert with Wilshire technicians, have reduced the intricacies of big rig movement to a fine art. It is really a revelation to observe the facility with which a very few men with a very few machines can juggle these tremendous weights. And the secret of transportation greatness is not alone in speed of movement. For example, no cellars are poured for these rigs. Standard cellars are precast in the Rumbaugh yard, and when the site of a new well is determined, the field men simply doze a hole in the ground, lay the cellar in it, and then fill in the earth around it. Saving in foundation and cellar costs alone amounts to $300 or $400 a well.

Following the partial unitization of the National 100, work was begun on a small rig, a National 50, and this represents the most advanced bit of drilling machinery condensing and consolidating that has yet been accomplished for land operations. This rig was equipped with a 126-ft derrick, a Lee C. Moore Ideo-type unit, with an 11-ft sub-base, designed especially for this job. It carries three N. K. U. Waukesha engines and is fitted with hydromatic and air clutches. The mud pumps are a National C-150 and a National C-250.

On top of the sub-structure in the engine house, along with the N.K.U.'s are two Palmer 15 kw light plants, a Hydril blowout preventer, and facilities for operating the hydraulic pump, and an accumulator. The C-150 pump, change room, and tool house, are on the left side of the sub-base. On the right side are 2 mud pits, the shaker screen, mud manifold, fill-up lines, lines to cellar jets, etc. The sub-base is about 64 ft long and consists again of parallel sections, joined by four crossing spacers. The front section carries the blowout preventer and rotary table as in the large rigs. The next 2 carry the water tanks, also as in the big rigs. The last section is the base for the C-250 pump and the water softener.

This rig moves in its entirety as one single package, and moving time from completion to spud within the area runs from 2½ to 3 hours, as compared with 2 or 3 days for a similar rig, non-unitized. It is so complete in its unitization that it could actually drill, if such a thing were necessary, while it is being moved.

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View of National 50 from mud pit side, showing larger pump, and mud walk folded back into moving position.

An additional advantage in the manner of arranging the equipment is that the derrick flooring immediately beneath the driller's position is made of expanded metal and is directly over the mud shaker screens so that the driller can keep a weather eye on the tailings without vacating his position. Another factor that minimizes cost and speeds time of relocation is that this small rig requires no matting. It sits right down on the bottom of the mud tanks, which in turn are well supported by the sub-structure cross-bracing and have adequate strength to support their portion of the total load.

Because of the speed of the moves, the drilling rates, and other appreciable considerations, it has been found that an operational program combining the use of the two larger rigs and the small completely integrated unit in equitable increments of time, results in an overall saving that makes the whole plan highly attractive. It is a brand new departure in project procedure that is working out in a most satisfactory manner. The *modus operandi* is simply to drill with the small rig to a depth of 6000 or 7000 ft, then move it off and complete the hole with one of the large units. Experience has indicated that the big rigs take twice as long to drill the wells to completion (i. e. approximately 13,000 ft) as the little one does to make the first stage. Since the small rig can be moved in 2 or 3 hours as compared with 7 or 8 for the big ones, it is able to keep comfortably ahead at all times.

Examining this unusual procedure from a cost basis, the savings soon become apparent. To begin with, the difference in cost of the rigs is an appreciable item. Exclusive of drill pipe, the two large rigs cost about $300,000 each, while the little one runs about $150,000. That is an immediate saving over the price of three large units of $150,000. The economies in moving costs have already been mentioned. There is a saving of about $13,000 per move of the big rigs, and it is worthy of note that this item is relatively unaffected by distance. Moves as far as 3½ miles have been made with little difference in elapsed time, hence no appreciable diminution of the saving. Then there is the operating expense: The big rigs cost from $1200 to $1400 a day to operate and the little one costs about $800, a saving of about $600 a day for the first 40 days of operation on each well —that's how long the little rig takes to make its 6000 or 7000 ft in the McElroy Ranch field. The completion to 13,000 ft by one of the large rigs takes an additional 80 days. The saving of operating time is, of course, partly offset by the cost of moving the little rig in and out but that still leaves a sizable margin in favor of the overall plan.

There are several other interesting features in the total set-up. Despite the difference in capacity, the three rigs are practically of the same weight. They tip the scales at about 500 tons apiece. This is due to the fact that there is no great difference in the two large units and the smaller one is so completely unitized that it almost catches up, weightwise, with the others. Wherever possible neoprene hoses are used so that any minor misalignments are taken up by the slack, and hooking up is a simple and speedy process. Of major import, too, is the

Close-up of one of the hydaulic jacks. They raise the beams to permit the Athey wagons to slide under or be withdrawn as the occasion demands.

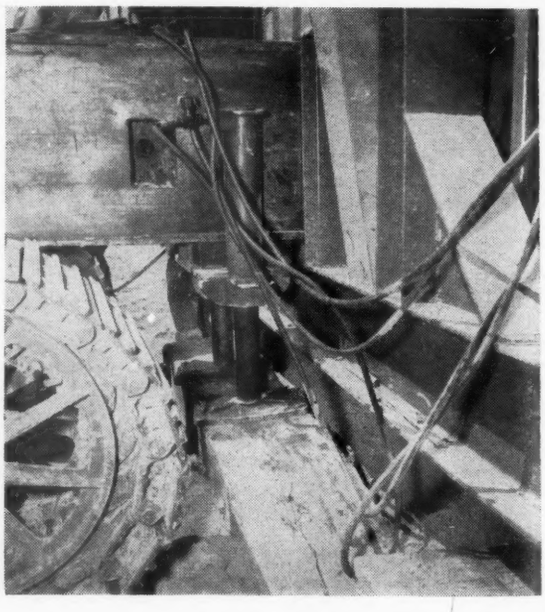

Photo shows method of hauling butane tank. All such separate packages for big rigs are balanced in this manner. The driver takes care of loading and unloading all by himself. No swamper is required

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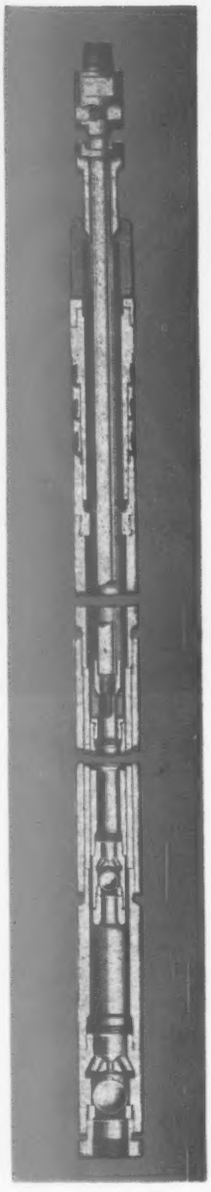

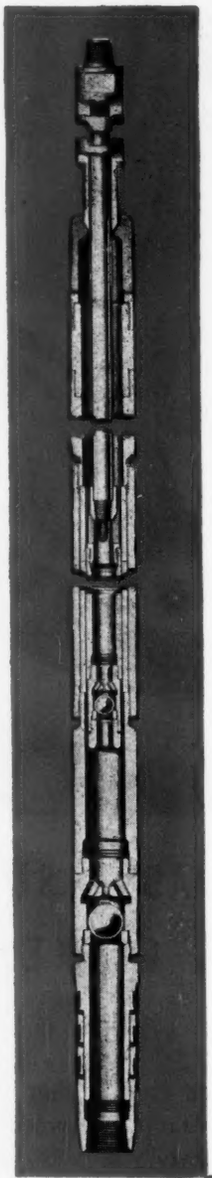

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fact that no outside help is required to make a move. The drilling crews and the Rumbaugh boys with their dozers and tractors handle the whole business in jig time and as nonchalantly as if they were moving a dog house.

It is intriguing, indeed, to see derricks moving along at a pretty fair clip as if actuated by their own power, while the crew members stand by at their regular stations and even the derrick man remains on the fourble board. Meantime, the dozers scuttle about, leveling off new sites in a matter of minutes, installing prefabricated cellars in a few more, and laying down matting if a big rig is coming in. Very quickly the beams are hoisted with the hydraulic jacks, the Athey wagons pull away, connections are tied in, and the spudding operation is under way.

This is the stuff of which superman stories are made. Yet it is simply an example of unhampered enterprise at work. It has always been our contention that petroleum people have a flair for the resolution of their own problems. Here we have a virile organization faced with the age-old need of performing the maximum in a production way with the minimum of expense. Waste—of time, effort or money—is detestable to an oil man, and the search for the more efficient, more economical way goes on and on. In its Texas operations Wilshire Oil Company has met the challenge of a new age, in which the keenest competition has forced scientific development to amazing new peaks. Wilshire has not only met the challenge of the moment but seems, by a combination of administrative understanding and engineering acumen, to have forged into the front of the operational picture.

Maurice Machris, the executive behind all this interesting development, has a philosophy that may be expressed in one word: "Action." He believes that a worthwhile idea should not be wrapped up in red tape and stored in the vault, but should be tested, now! He further believes that the consummation of any business deal demands immediate action from one or other of the parties, and preferably both. He has industrial daring and is not afraid to invest in his own beliefs or those of his associates. He gets a real thrill out of accomplishment and is naturally proud of his company's success in West Texas. His recent experiences have engendered in him a tremendous admiration for the people of West Texas who helped in a very substantial way to translate Frank Lake's land barge dream and the dual-rig operation idea into efficient and exciting realities. * * *

Study Reservoir Data

The need for thorough investigation to determine whether the characteristics of petroleum are uniform throughout a given underground reservoir is emphasized by a Bureau of Mines report released by Secretary of the Interior Oscar L. Chapman.

The report is based on a comprehensive study of the characteristics of the original oil in the Weber sandstone reservoir of the Rangely field in Colorado. The study, undertaken in 1945 continued for three years and developed data that have been used by several companies producing oil from that reservoir. The report was prepared by Cecil Q. Cupps, Philip H. Lipstate, Jr., and Joseph Fry, Bureau engineers at Laramie, Wyoming.

The characteristics of representative subsurface oil samples, as determined by laboratory analyses, were correlated with the depths at which they had been taken. It was found that not only did the degree of gas saturation of the oil decline with depth below the initial gas cap, but also that the composition of the gas varied with changes in elevation. In addition, the viscosity and density of the oil increased with depth.

A free copy of Report of Investigations 4761, "Variance in Characteristics of the Oil in the Weber Sandstone Reservoir, Rangely Field, Colorado," can be obtained from the Bureau of Mines, Publications Distribution Section, 4800 Forbes Street, Pittsburgh 13, Pennsylvania.

Bishop Opens New Offices

Bishop Oil Company has opened a new field office at Scottsbluff, Nebraska, and a new district office in Bismarck, North Dakota, W. W. Mein, president has announced.

Burr M. Roberts has been appointed geologist in charge of the Scottsbluff office, and will conduct the company's exploratory activities in the Nebraska area. He returned recently to the U. S. from the company's operations in the Redwater oil field of Alberta Province, Canada. The Scottsbluff office is situated at 1818½ Broadway.

Jean L. Lee will be in charge of the Bismarck office. He was formerly geologist in Oklahoma. New office address is 107½ Fourth Street.

AIME Dallas Office Moves

The Petroleum Branch, American Institute of Mining and Metallurgical Engineers, has moved to 408 Trinity Universal Building, Dallas 1, Texas. The publication offices of the *Journal of Petroleum Technology* will also be situated at this address, AIME secretary, Joe B. Alford, announced.

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If you are operating high-pressure oil or gas wells near highways or town sites, or in rivers, lakes, canals, or off-shore locations subject to seasonal storms, you need the 24-hour protection of Otis "Storm Chokes." Then if surface connections should become damaged, or if the flowing pressure should rise or fall beyond safe or practical limits, this dependable safety device will instantly snap to a positive shut-off to close in the well *below the surface.* Otis Tubing Safety Valves are available in several different types for various producing conditions, and for wells with or without previously installed Otis Landing Nipples *(Type FS with Otis Equalizing Sub, illustrated).* They can be run in and removed with regular Otis running and pulling tools and wire line equipment easily and quickly, under pressure, without pulling the tubing, killing the well, or disturbing normal production. A call to the nearest Otis office will bring you complete details and illustrated literature, or a recommendation as to the specific types of Otis Tubing Safety Valves for your particular wells. Investigate this safety device . . . we'll be glad to discuss it with you, and afterwards you'll be better informed on a better way to protect your high-pressure production.

A new 8-page, illustrated bulletin on the entire line of Otis Safety Valves may be obtained without obligation at Otis field offices, or by writing us at Box 7206 in Dallas. The bulletin contains descriptions of the Type X and the new Type A Otis Surface Safety Valves, and complete operating and design details on the Otis Tubing Safety Valves discussed above.

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Canadian Oil Supply

In an address before the American Society of Mechanical Engineers at the Royal York Hotel in Toronto, Canada, Dr. Oliver B. Hopkins, vice president of Imperial Oil Ltd., of Canada, has disclosed that the fabulous oil fields of Alberta have raised that country's total annual crude oil production to nearly one-half of its total needs. Alberta oil fields supply one-third of Canada's current petroleum requirements. Contrasting this with domestic production, which amounted to only 7 per cent of consumption in 1947, the year of the discovery of the western oil deposits, Dr. Hopkins described the effect of this development on the economy of the west and Canada as a whole.

Assuming that Canada's oil consumption continues to increase as it has in the last several years, and that no large new discoveries are developed in the meantime, Dr. Hopkins estimated "conservatively" that the country would be 40 per cent self-sufficient in crude oil in 1953.

He said the combined market for crude oil produced in the Alberta prairies this year will be about 115,000 to 120,000 bbl daily or about one-third of Canada's current daily consumption of 350,000 bbl. The western oil is delivered to Ontario refineries by pipe line, which also runs close to all the major prairie refining centers except Calgary. The pipe line was completed last year.

Economic Benefits

Dr. Hopkins said the oil discoveries have proved a boon to the agricultural economy of the west, which previously had to pay high prices for the petroleum it was forced to import for its mechanized farming equipment. Petroleum product prices are now about 10 cents less per Imperial gallon than formerly, he said.

"In terms of the prairie economy as a whole, the saving to consumers is running in the neighborhood of $55,000,000 this year or close to $22 for every man, woman and child in the three provinces," he declared.

"These advantages of price reductions and foreign exchange savings have been augmented by the vast capital investment that has taken place. By the end of this year, some three-quarters of a billion dollars will have been invested in crude oil exploration and development, in transportation and in manufacturing facilities. Far the greater part of this investment has occurred in western Canada where they combined with the benefits of low prices and plentiful petroleum supplies to provide a very powerful economic stimulus.

New Industries

"In Alberta there has been a marked increase in population, a widespread development of new industries allied with oil production, and a substantial improvement in government revenues. This year it was announced that the Celanese Corporation would construct a $40,000,000 chemical plant at Edmonton, a development that may work a turning point in the prairie road of industrialization."

The wave of exploration since the strike at Leduc has resulted in the discovery of a number of new fields and the addition of more than a billion barrels of oil to Canada's petroleum reserves. He estimated that some $200,000,000 will have been spent on exploration and development in western Canada by the end of the current year, an increase of $50,000,000 over 1950 and double the amount spent in 1949. Last year, he added, 1017 wells were completed involving over 2,900,000 ft of drilling—or 530 miles. While Leduc and the adjoining Woodbend pool are estimated to contain some 200,000,000 bbl of recoverable crude oil, the famous Redwater discovery 35 miles northwest of Edmonton, is put at some 500,000,000 bbl.

Dr. Hopkins pointed out that the Redwater volume is more than the average reserves discovered annually in the past 10 years in all the new fields in the United States. He said Canadian demand for oil has risen from 255,000 bbl required daily in 1947 to the present figure of 350,000 bbl, an increase of 37 per cent.

More Storage

In 1952, Dr. Hopkins reported, the Interprovincial Pipe Line Company plans to expand the throughput of its pipe line by the addition of 6 new pumping stations and the construction of 2,600,000 bbl of additional storage at Lake Superior. The construction of an additional large tanker that is underway will permit the movement to Ontario Province to increase to roughly 18,000,000 bbl in 1952 as compared with 12,000,000 for 1951, he said.

The net effect of this will be to raise output in the prairies to 145,000 bbl daily in 1952, an increase of some 25,000 bbl a day over the 1951 average, Dr. Hopkins said.

December Oil Output Down U.S.B.M. Report States

World crude petroleum production in December averaged 11,113,000 bbl daily, a decrease of 48,000 bbl daily from the November rate, according to a Bureau of Mines report. The production decrease in the United States of 172,000 bbl daily, and in Canada 22,000 bbl daily, more than offset the production increases in the other major producing areas of the world. The largest gains in daily average production over November were: Iran 70,000 bbl, Indonesia 27,000, and Venezuela and Iraq each 10,000 bbl.

New monthly production records were attained in Venezuela, Colombia, Kuwait, and France in December. During the fourth quarter of 1950, world crude oil production averaged 11,151,000 bbl daily, an increase of 3.4 per cent over the third quarter daily average. Daily average production for the last six months of 1950, was 12.7 per cent higher than the average for the first half of the year.

Crude oil imports of western Europe increased 9000 bbl daily to 850,000. The principal importers were, in barrels daily: France 296,000 (November, 320,000), United Kingdom 232,000 (181,000), Italy and Trieste 127,000 (117,000), the Netherlands 126,000 (114,000), and western Germany 45,000 (67,000).

Shell Buys Oil Property

A major oil land transaction involving 940 acres with 32 producing wells was consummated when F. E. Fairfield, Long Beach oil man, sold, for an undisclosed amount, his South Mountain holdings near Santa Paula to Shell Oil Company, according to a joint announcement by the two principals. Present daily production from the oil wells involved in the sale is approximately 2500 bbl per day. The first lease was acquired by Fairfield in 1942 and since then several have been added to the original lease. The property is on the top of South Mountain. Present wells have been developed by directional drilling from a series of island bases with individual wells producing from 100 to 500 bbl per day.

OIIC Prepares New Film

To help oil employees keep fully informed on the industry's ability to meet military and civilian defense requirements, the Oil Industry Information Committee has produced a new slide-motion film giving informed answers to key questions on preparedness. Entitled "On Our Toes," the new slide-motion film explains the industry's current position and points out why it will be capable of meeting military requirements promptly.

Reservoir Conditions of Redwater Field

An accelerated decline in field average bottom hole pressure is accompanying the fuller development of the Redwater oil field, according to the latest report on reservoir conditions published by the Petroleum and Natural Gas Conservation Board. At the inception of the field, bottom hole pressure was about 1050 psig. To the end of February 1951, the average of all wells in the field was down to about 935 psig. By that time the total number of wells capable of producing was just short of 800 and it has been increasing by close to a well a day since then, with expectation that full development of the field will comprise more than 1000 wells.

Although the Board report does not give current figures on maximum and minimum break horsepower, it must be assumed that many of the wells completed early in the life of the field have declined materially. The rate of decline has, however, been quite steady over the life of the field, with an acceleration in the last five months to the end of February. This acceleration, presumably, would be due to the slowing of new well completions as contrasted to the three per day average last summer, with the result that declines in existing wells would not be offset by initial pressures in new wells.

The problem of edge water intrusion will become more serious for wells on the shallow slope of the west flank, but officials of Imperial Oil Limited, operator of the only water level observation well at Waybrook, approximately three miles west of the center of the west flank, have stated that no conclusions will be capable of being drawn about these observations for several months more. As there is no gas cap, primary drive mechanism is entirely water: Hence the importance of studying the movement of the field water line. All wells are equipped with pumps immediately on completion. Considerable experimenting has been done with sucker rod scrapers to remove paraffin accumulation, which is a problem on account of the production method of drawing several days' average allowable from each well on a lease each day, then shutting down and drawing from the other wells in rotation, usually by groups of four.

Oklahoma University Given Four Graduate Fellowships

The Oklahoma University, school of petroleum engineering has announced four graduate fellowships for the academic year 1951-52. They include: Sinclair Refining Company, $1500 with $1000 per year which is made available for tuition, lab fees, special equipment, and materials, and other similar expenses necessary for the research project; Humble Oil and Refining Company, $1250, plus $300 per year; Shell Oil Company, $1250, plus $300 per year, and Stanolind Oil and Gas Company, $1250, plus $500 per year. Applications are being received by H. W. Benischek, school of engineering, University of Oklahoma.

Oil Storage Tanks Planned

Twenty-two firms have been authorized to use defense order ratings for delivery of almost 15,000 tons of steel to build storage tanks for 3,167,500 bbl of heating oil and gasoline, the Petroleum Administration for Defense has announced. Surveys of petroleum storage needs in areas where navigation is blocked by ice during winter months revealed the necessity of such facilities.

Contracts Signed for Exploiting De Mares

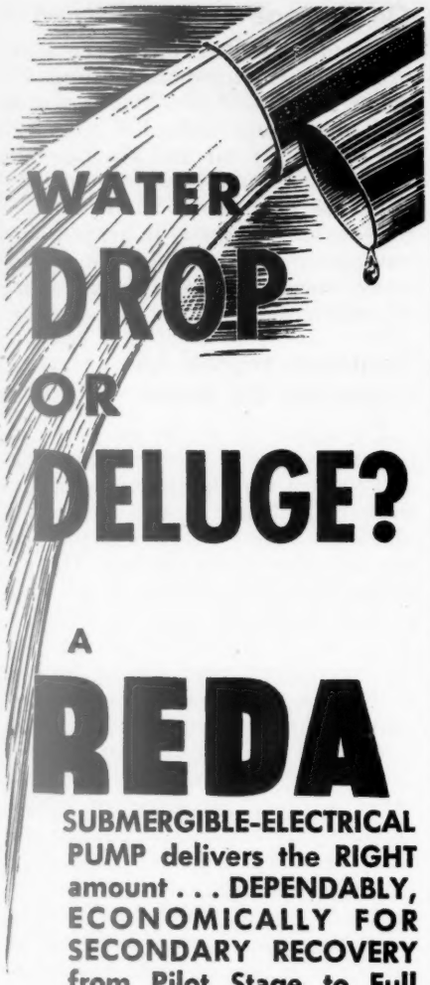
Two contracts are to be made between the new Empresa Colombiana de Petroleos and the International Petroleum Company. One is for the exploiting of the De Mares concession and the other is for refining. The exploitation will be limited to the area already developed (some 35,000 hectares out of the 480,000 comprising the concession) (and will be limited to the area already developed) operated for the Empresa, the contractors receiving 4 per cent of gross production during the first year, payable either in crude petroleum or in Colombian currency, 3 per cent the second year, and 2½ per cent thereafter.

In the refining contract the company will put 20,000,000 pesos into the extension and modernization of the plant, in the form of a 10-year loan bearing interest at 4 per cent. The Empresa will receive payment rising from 7 to 18 centavos per barrel of crude petroleum treated and 75 per cent of the profits.

Chairman of the House Committee Ed Bartosh, Bankline, presents leather box of dominoes to W. E. "Bill" Morgan, Union of California, who, with Basil Kantzer, also of Union, were winners of the Consolation flight.

Petroleum Club Domino Meet

E. J. "Ed" Bartosh, below right, presents engraved walnut boxes of dominoes as trophies of the Second Domino Tournament to winning team of Fred Keller, Oceanic Oil Company, and L. L. Aubert, Bankline. W. H. Geis on left and A. C. Rubel (not in photo), Union of California, were runners-up in the Petroleum Club of Los Angeles tournament.



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Reda Pumps produce the largest volumes obtainable from 5½", 7", 8⅝" casings, often reducing the required number of source wells. Corrosion resistance built into Reda Pumps materially prolongs time between pulling jobs, where corrosion is a factor.

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To fit the changing needs for water volume as the flood progresses, Reda Pump can readily be altered or changed to larger or smaller sizes.

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BARTLESVILLE, OKLAHOMA

Operators Study Proposed Unitization Program

More than twice as much oil would be obtained from the prolific reef reserves if all interests could be pooled, or unitized, was the consensus of 41 operators meeting in Fort Worth, Texas, recently. The meeting was called by D. R. Snow, Tulsa, Oklahoma, chairman of the Scurry County area reef operating committee and vice president of Sunray Oil Company, for the purpose of acquainting all the operators with petroleum engineers' recommendation and legal aspects of the proposed unitization program.

Pooling or unitization would be required for active productive areas, including the Diamond-M, Sharon Ridge, and Kelley-Snyder fields.

The operators, in recommending unitization and pressure maintenance cited recent tests that show the canyon reef pool of Scurry County to be unusually well adapted so that injection of water and gas would cause a great increase in the amount of oil recoverable. Two oil wells have been converted for trial—or pilot injection of gas—and one well converted for water injection. These wells are in the approximate centers of the three fields, thought by many engineers to be one single reservoir.

Dozens of injection wells must be employed in order to displace appreciable amounts of oil efficiently from the entire huge pool. As oil and gas would be pushed across the existing property lines by such injections, operators are generally in favor of pooling of leases and royalty so as to allow each well at each part of the pool to be operated in the most efficient manner.

This pooling type of unitization is relatively new to the oil industry but is being applied very successfully in every one of the few but increasing numbers of Texas oil and gas fields so operated.

The Scurry reef area involves approximately 80,000 acres on which some 1800 oil and gas wells are now producing. More than 250 separate leases, approximately 90 operators and some 5000 royalty owners would be involved in the pooling and unitization effort. The reef production was first announced in November 1948.

Iran Output Down in April

Anglo-Iranian Oil Company, Ltd., has reported production of crude oil in Iran for the month of April amounted to 2,217,000 long tons, compared with 2,837,000 long tons in March. Total production for the period January 30 to April 30 was 10,258,000 long tons.

Training Course Planned

A new training course for oil and gas workers was discussed at the American Petroleum Institute, Division of Production, mid-year committee conference held in the Brown Palace Hotel, Denver, Colorado.

Rocky Mountain, Southwestern, and California oil executives and state vocational training officers heard John A. Ritter, Sun Oil Company, Dallas, Texas, the chairman, describe plans for a course on natural gas handling practices now under preparation by the API vocational training subcommittee in cooperation with the University of Texas. The course will be ready in 1952 and will be taught to oil field workers throughout the United States by traveling instructors employed by the vocational training departments of the oil producing states.

Sinclair Office Moved

Sinclair Oil and Gas Company has announced that the district production office for the Mississippi and Louisiana south district has been moved from Jackson to Natchez. F. H. Rhees, general production superintendent made the announcement, along with various promotions and transfers in the department.

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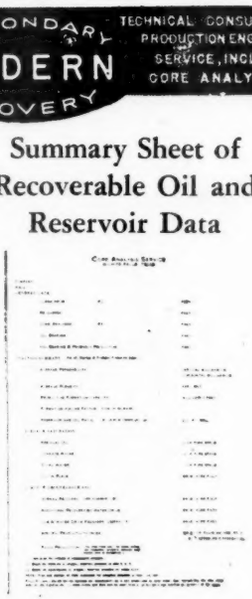
Summary Sheet of Recoverable Oil and Reservoir Data



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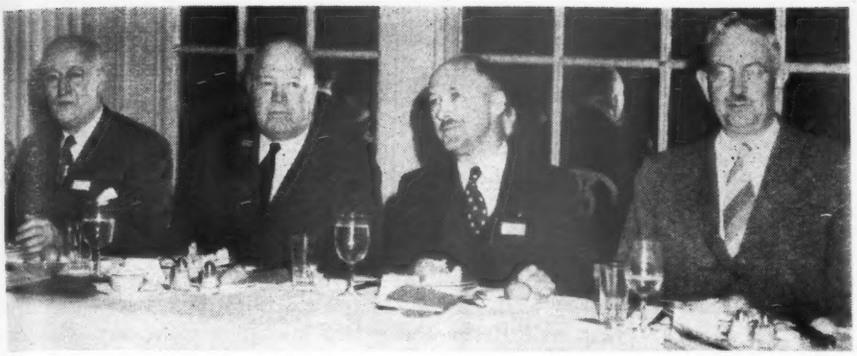

Shown at a recent meeting of the New York chapter of Nomads are: A. A. Dill, vice president, New York Nomads; Frank M. Porter, president, American Petroleum Institute; Howard B. Book, president, New York Nomads; and W. H. Ferrand, general manager, foreign production department, The Texas Company.

SEG Plan Fall Meet

The Society of Exploration Geophysicists will hold its annual midwest regional meeting November 19 and 20, 1951, at the Baker Hotel in Dallas, it was announced by Dr. Karl Dyk, of Stanolind Oil and Gas Company, Tulsa, chairman of the program and arrangements committee. Dr. Dyk said that the meeting will be sponsored jointly by the Dallas, Fort Worth, Midland, Shreveport, and Tulsa local sections of the SEG, and the Geophysical Society of Tulsa will be responsible for the program and arrangements through his committee, composed of members of the Tulsa section.

Dr. E. M. McNatt, of Carter Oil Company, is in charge of the two-day technical sessions; Jay P. Garner, president of Oil Exploration, Inc., will arrange the entertainment; and K. M. Lawrence, Amerada Petroleum Corporation, will accept advertising for the printed program. Other members of the Tulsa section serving on the arrangements committee are Dr. W. H. Courtier, of Phillips Petroleum, Bartlesville, and Frank Searcy, of Continental Oil Company, Ponca City.

Venezuelan Oil Output Sets New Record in April

Venezuela's oil output reached a new high in the week ending April 30, with an average daily production of 1,703,564 bbl. For the first quarter, that country averaged 1,650,000 bbl a day compared with an average of 1,392,483 bbl a day in the same period in 1950.

New records have also been set by one of the principal oil companies in Venezuela, Creole Petroleum Corporation, which produced an average of 750,000 bbl a day in April, the biggest month in the history of the company. The week ending April 16, was the most productive with a daily average of 754,000 bbl.

Texaco Plans New Offices

A 16-story office building will be erected in New Orleans, Louisiana, by The Texas Company at the corner of Canal and Marais Streets as division headquarters for the sales and producing departments, the company announced. Construction is scheduled to begin immediately and will require about 15 months.

In making the announcement, the company reported notification has now been received from the National Production Authority that a permit has been granted for the building project. Steel and other critical materials have been on hand several months for the construction job.

American Standards Increased

Ninety-nine new and revised American Standards are listed for the first time in the latest edition of the Price List of American Standards just published by the American Standards Association, 70 East 45 Street, New York, New York. This list contains more than 1180 standard specifications, methods of test, and symbols, and abbreviations in civil engineering and construction, mechanical engineering, electrical engineering, safety codes, ferrous and nonferrous materials, and metallurgy, etc.

Returns to Magnolia

O. E. Van Meter, Jr. has been made assistant division petroleum engineer of Magnolia Petroleum Company's Gulf Coast Division with headquarters at Houston, Texas. Van Meter has been on a leave of absence for the past nine months taking graduate work at Texas A. & M. College. Before that time he was a petroleum engineer in Magnolia's West Texas division. William E. Allen has been promoted from assistant foreman in Magnolia's Brownfield, Texas, producing district to production foreman in the Kermit district, the company reported.

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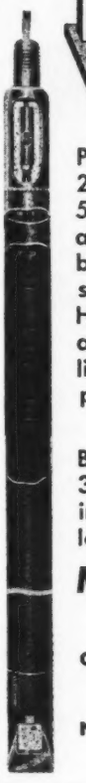

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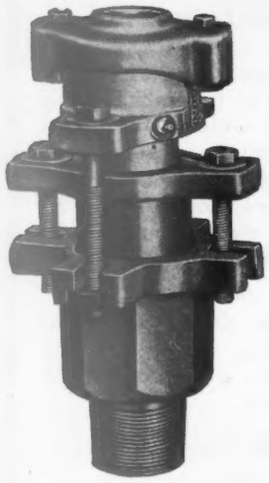

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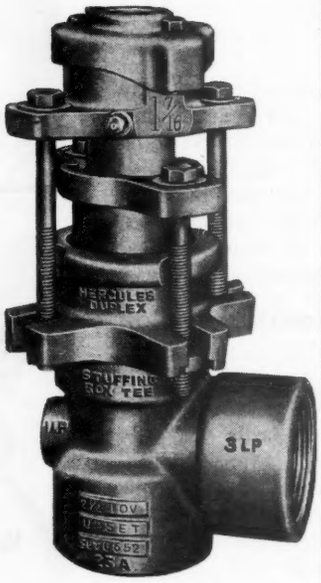

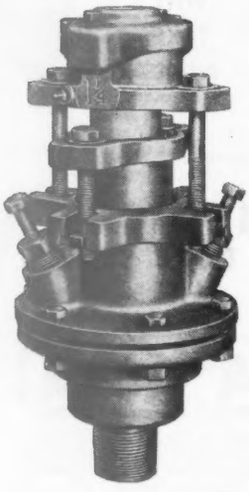

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Increasing Petroleum Yield Studied at Gulf Meet

Reviewing the problems and current progress in recovering more oil from the world's petroleum reservoirs, Gulf Oil Corporation held the sixth and largest production engineering conference in its history recently in Pittsburgh, Pennsylvania.

Those attending heard 30 technical papers presented at seven technical sessions, took part in related discussions and conferences, inspected current research projects at the Gulf laboratories, Harmarville; and viewed production facilities at the Jones & Laughlin Steel Corporation's Aliquippa plant, Westinghouse Electric Corporation's East Pittsburgh plant, and Parkersburg Rig and Reel Company, Parkersburg, West Virginia.

Dr. Joseph E. Pogue, member of the company's board of directors and petroleum consultant, Dr. K. C. Heald, vice president, production, and E. P. Hubbard of the Houston division, for the past two years chairman of the company's production research coordinating committee, gave the opening addresses.

Major emphasis was given to problems of lost circulation and squeezing more production from existing fields.

The initial session, on drilling practices, heard reports on techniques being developed for overcoming pressure surges that are a principal cause of lost circulation in wells; economies that have been applied to drilling operations in E. Venezuela; jet perforation experiments revealing advantages of shooting with oil opposite the zone to be perforated; the advantages of oil emulsion drilling muds, and promising developments in rotary percussion drilling tools.

A workover methods symposium took up the economics of remedial work and the mechanics of correlating data on individual wells and reservoirs by production, engineering, and geological staffs. Workover methods employed at Lake Maracaibo and the Fruitvale field, California, and favorable results of hydrafracing and stratalifting in reservoirs producing under dissolved gas drive, were discussed.

The problems and advances in increasing the well potentials of the vast Burgan field, Kuwait, were reviewed in a production engineering session. The same group heard of the advantages of electrostatic dehydration for heavy crudes such as produced in Western Venezuela, the progress made and variations encountered in treatment of heavy crude emulsions in other areas, and increased recovery through low temperature separation.

Advantageous experience with hydraulic oil well pumping in West Texas was reported in an artificial lifting session. Following papers dealt with conditions under which submergible, multistage pumps can be employed economically, and with the use of the newly developed Gulf Sonic fluid level indicator, which is capable of measuring fluid levels at depths greater than heretofore possible. Conditions were outlined where gas lifting proved the most economical artificial lifting method.

A secondary recovery meeting discussed the criteria for determining application of secondary recovery methods.

A symposium on automatic equipment studied prospective economies of such installations in more efficient use of manpower and longer life of equipment. Operation of fully automatic leases was described and the prediction made that this method of production would be substantially extended in the near future. Possibilities of metering crude oil in production operations were discussed, and drilling, producing, pipe line tools under development by Gulf were described.

Research on inhibitors for preferential oil wetting of subsurface equipment in production use was summarized in the final corrosion session. Also detailed were difficulties with stress corrosion cracking of steel under sulfide conditions in the Pincher Creek, Canada, field. A pilot test program for investigating materials and methods for producing under the highly corrosive conditions there was described.

GROVE

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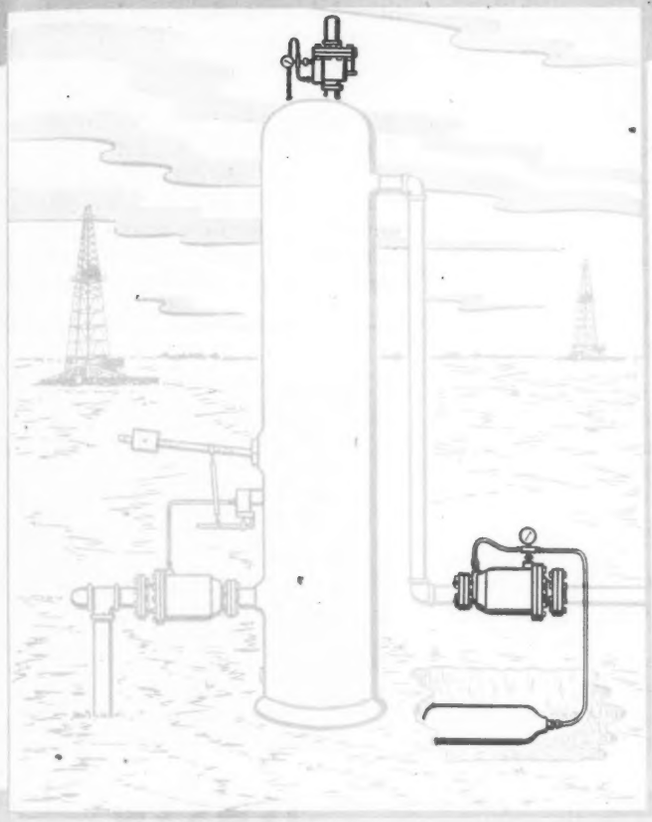

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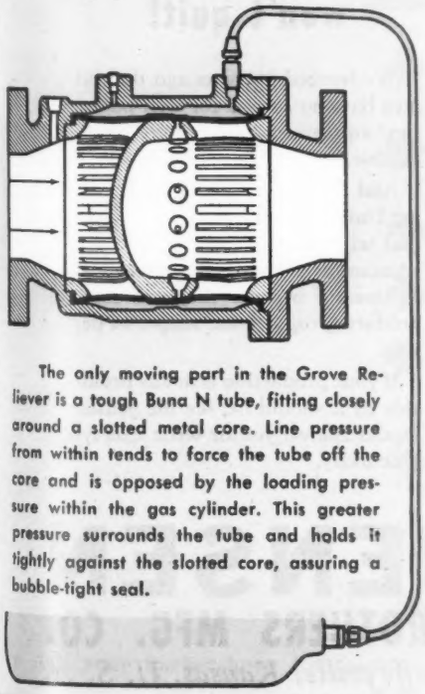
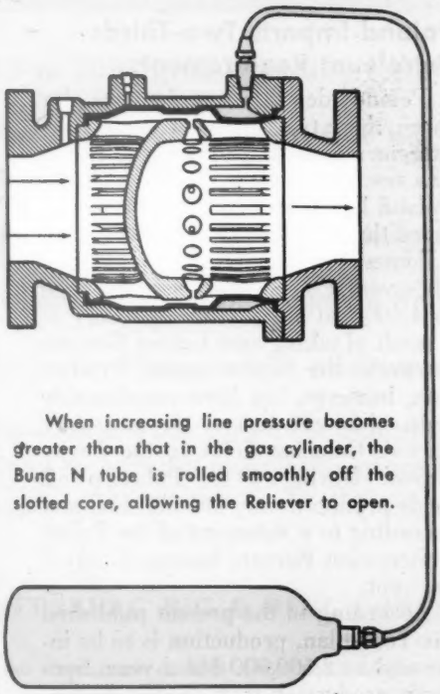


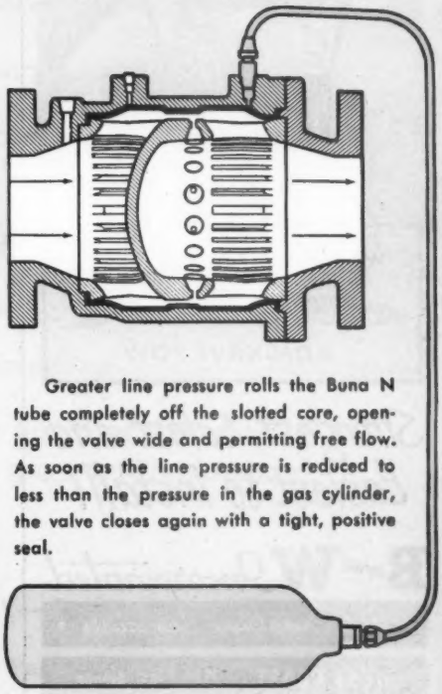
The only moving part in the Grove Reliever is a tough Buna N tube, fitting closely around a slotted metal core. Line pressure from within tends to force the tube off the core and is opposed by the loading pressure within the gas cylinder. This greater pressure surrounds the tube and holds it tightly against the slotted core, assuring a bubble-tight seal.

PARTIALLY OPEN POSITION



When increasing line pressure becomes greater than that in the gas cylinder, the Buna N tube is rolled smoothly off the slotted core, allowing the Reliever to open.

WIDE OPEN POSITION



Greater line pressure rolls the Buna N tube completely off the slotted core, opening the valve wide and permitting free flow. As soon as the line pressure is reduced to less than the pressure in the gas cylinder, the valve closes again with a tight, positive seal.

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Austrian Oil Output Reached Peak in 1950

The Soviet-administered Austrian oil region is reported to have produced approximately 1,500,000 tons of crude oil in 1950, compared to 1,250,000 tons in 1949, 960,000 tons in 1948, and 450,000 tons in 1945, according to figures carried by a U. S. Bureau of Mines release. Thus, the 1950 production was said to be the highest on record and substantially exceeded the previous peak of 1,210,000 tons, reached in 1944, when available resources were exploited. Austrian oil men who claim access to information about the region dominated by the Soviets, made the estimate.

The Zistersdorf wells, which have been in production for 17 years, at present yield a monthly total of about 100,000 tons of crude oil. The fields at Matzen, opened up in 1949, produce 20,000 to 30,000 tons, while a new field, Aderklas, which began producing last year, accounts for a further 20,000 tons a month. The Russians are now carrying out exploratory work in the region of Brockfliess.

The report also stated that the yield of petroleum products in Austria is very unsatisfactory, because of the out-of-date equipment of the 7 refineries, which have an aggregate capacity of 1,200,000 tons per annum. About 50 per cent of the throughput becomes heating oil, so that there is a surplus of this product and a shortage of gasoline. Only two of the refineries have cracking installations.

Poland Imports Two-Thirds Petroleum Requirements

Poland depends on imports for more than two-thirds of its oil requirements, the U. S. Bureau of Mines has revealed. Before World War II, Poland had a domestic production of more than 3,700,000 bbl a year, and a domestic consumption of 3,000,000 bbl a year. Consumption has increased to 4,500,000 bbl a year, especially as a result of taking over former German territory, the report stated. Production, however, has been considerably reduced by the loss of the most productive Galacian fields to the Soviet Union. During 1949, Poland's oil fields produced only 965,000 bbl, and according to a statement of the Polish Information Bureau, increased only 5 per cent.

According to the present published Six-Year Plan, production is to be increased to 2,600,000 bbl a year. Synthetic production from the two hydrogenation plants, Blechhammer and Heydebreck, as well as from the Fischer-Tropsch plant, is estimated at 850,000 bbl yearly. Natural gas production may have amounted to about 200,000,000 cu meters, corresponding to a heat-value of 1,332,000 bbl of fuel oil; however, natural gas is not everywhere in a situation to be substituted for petroleum and petroleum products. Therefore Poland is impelled to import mineral oil.

Through an agreement with the United Kingdom, 1949, deliveries of oil from the Middle East are to be at the rate of 1,350,000 bbl and are to be increased by 1953 to 1,500,000 bbl annually. Of finished products, about 1,500,000 bbl were imported in 1949, chiefly from the USSR and Rumania.

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WHAT'S DOING IN DRILLING

New Well Drilled in Oklahoma Oil Pool

Another good well has been drilled in the Southwest Maysville pool of Garvin County, Oklahoma. It is Sinclair Oil and Gas Company's No. 1 Holloway, which has a plugged back depth of 8643 ft. The new well perforated a 2-ft section of the Oil Creek sand between 8321-23 ft, and on drillstem test, with tool open 8 hours and 50 minutes, it had oil to the surface in 20 minutes, and flowed 507 bbl of 45 gravity oil in 8 hours, plus 2,390,000 cu ft of gas per day. Flow was through 5/8-in bottom and 1/2-in. top chokes.

Continental Drills New Wyoming Field Well

Continental Oil Company has a new well in the prolific Sussex field, Johnson County, Wyoming. It is the Unit 59, which flowed 32 gravity oil on a packer test between 9115-9129 ft and 9130-9172 ft. A core from 9182-9196 ft recovered 14 ft of sand ranging from good to spotty saturation. A test between 9172-9196 ft, open 12 minutes, recovered 1900 ft of oil. Tensleep was topped at 9111 ft and the operator is coring below 9223 ft. The well is scheduled to go through the Madison.

New Drilling Firm Set-Up

A new drilling company has been organized in Russell, Kansas. It is the Sidey Drilling Company, with headquarters in the Building and Loan Building, Russell, Kansas. Associates in the firm are V. D. (Red) Sidey, who is also owner of V. D. Sidey Oil Company; A. E. (Gus) Byrne, formerly with Murfin Drilling Company, Otis (Toad) Cummins, all of Russell, and E. D. (Ed) Bradstreet, formerly a Topeka landman who is moving his office to Russell.

Carter McClain Well Flows 25 Bbl of Oil Per Hour

Carter Oil Company's No. 2 Johnson in McClain County, Oklahoma, has been drilled to a total depth of 9011 ft. On drillstem test between 8975-9011 ft, with tool open one hour and 10 minutes, gas showed in 25 minutes at a rate of 260,000 cu ft a day. The water load was recovered in 54 minutes and 32.5 gravity oil began flowing at a rate of 25 bbl an hour through a 5/8-in. choke.

Drilling Due to Slacken In Canada's Redwater Area

Drilling may slacken in the Redwater field, Calgary, Canada, in the latter half of this year, after 2½ years of rapid development. Imperial recently brought in 5 producers in one week, all around the producing edges, 4 of them in the Simmons perimeter. Although Redwater might ultimately total 900 wells, 841 have already been drilled. A total of 35 locations have been spotted at Redwater, but of these 14 have been listed for many months and in many cases are too questionable to drill.

Osage Oil Wells Undergo Water-flooding Treatment

In a move that make the Osage Indians the wealthiest Indians in the world, water-flooding of once-abandoned oil wells near Bartlesville, Oklahoma, was begun. In ceremonies conducted by 16 oil companies and the tribal council, the flow of water from wells along the Arkansas river was begun. The water was forced under pressure through the once-producing oil sands 7000 ft beneath the Osage nation. Water flooding of the oil sands is expected to force 140,000,000 bbl of oil to the surface during the next 28 years.

Income Tax Changes Affect Drilling Operations

The encouragement of diversion from development to wildcat drilling, which was made an expression of policy by Imperial Oil last fall, has been given an official assist by Canadian income tax changes and continuations provided for in the budget speech of the minister of finance, Hon. Douglas Abbott, in the House of Commons on April 10.

The most important provisions that should hasten the diversion of rigs to wildcatting are the extension of certain deductions for another year. The special deduction from income and taxes with respect to expenditures on deep test oil wells is extended to 1952, and for ordinary operations to 1954. This provides exemption from taxable income of drilling and exploration costs, including geological and geophysical expenses incurred in exploring or drilling for oil and natural gas in Canada. This applies both to companies and to unincorporated bodies such as associations, partnerships, or syndicates.

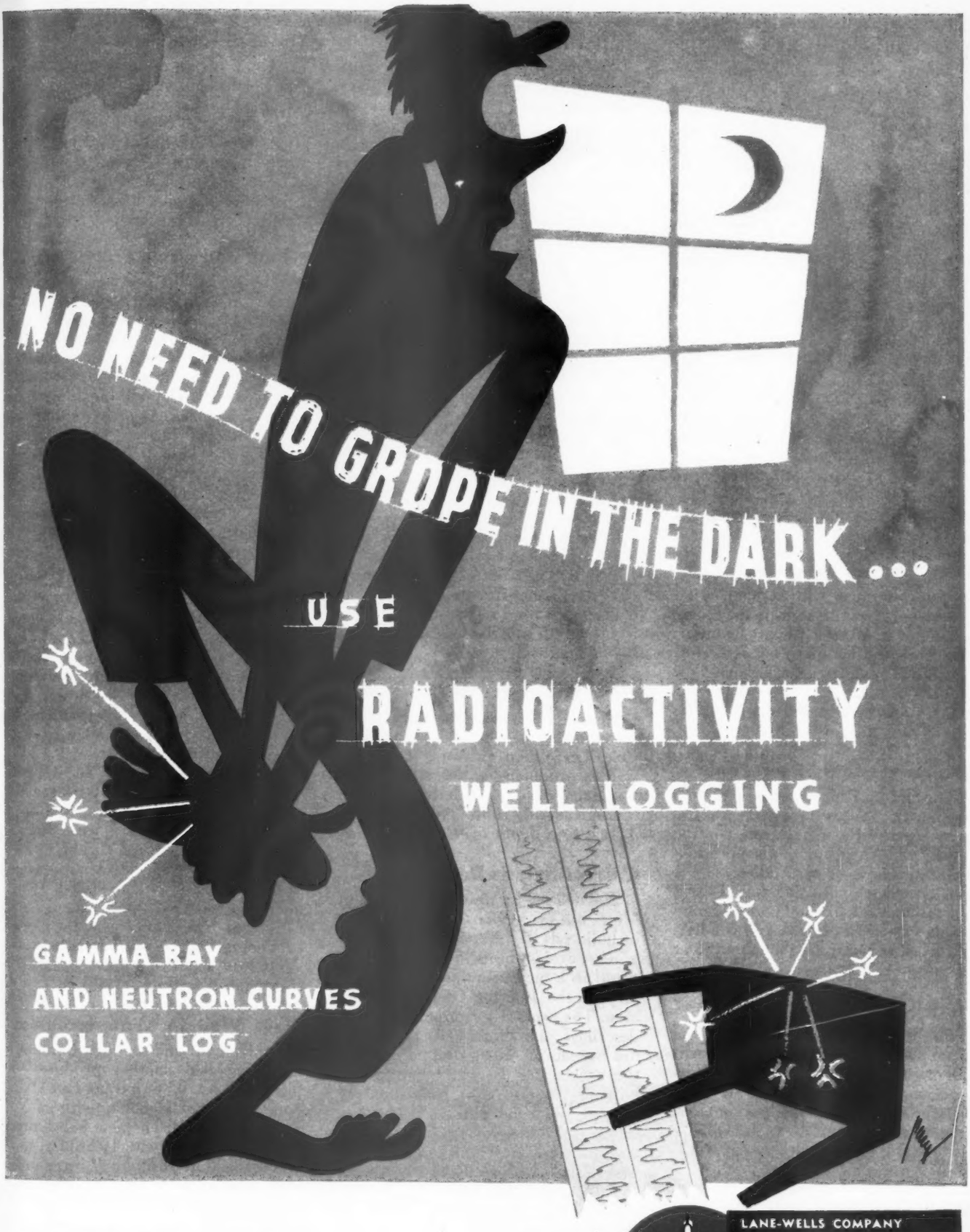
The deep test wells deduction applies to "the testing of a significant geological structure by a deep test well" that proves unproductive and has been spudded in up to the end of 1952. It also applies to a group of test wells on a significant stratigraphic trap, drilled to a depth of at least 25,000 ft and all proving dry, provided such drilling is shown to have been desirable in order to extend Canadian petroleum resources.

For most companies, depreciation on assets acquired after the date of the budget speech will be held in suspension for four years, during which the normal tax rate is probably going to remain high. Exempted from the deferment are expenditures on capital assets for oil and gas well equipment and gas distribution equipment. Equipment for oil production and distribution will be exempt at the discretion of the minister of trade of commerce on special application. Cumulatively, the effect of these provisions should be to concentrate attention still further on the exploratory drilling side of the industry. The approaching scarcity of enough steel to satisfy over-all demands from all branches may have a concurrent effect on diverting activity in that direction.

Rotary rigs operating in oil fields of United States and Canada*

	Total	Gulf Coast	Pacific Coast	Oklahoma Kansas	Arkansas Louisiana Texas	Rocky Mountain Canada	New Mexico West Texa
Weeks (May)							
Third	2618	557	157	461	144	264	878
Fourth	2578	567	150	391	153	177	883
Weeks (June)							
First	2640	583	140	452	161	274	872
Second	2637	573	140	349	154	287	881

*As reported to American Association of Oilwell Drilling Contractors by Hughes Tool Company.



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Shell Oil Well Sets New Louisiana Depth Record

Louisiana has a new deep hole record, set recently by Shell Oil Company at its No. 1 H. T. Gonsoulin in Weeks field of Iberia Parish. The well is now drilling below 16,240 ft, to break the old record of 16,237 ft set by Placid at its No. 1 City of New Orleans wildcat in Lafourche Parish. It is not known how deep Shell plans to go with this well. This is the second record Shell has set in Louisiana. The other is for deepest production at the No. 2 Weeks Gall State Unit where production is from 15,148 ft.

Gulf Well Gets Big Flow

Gulf Oil Corporation has a new well in Oklahoma County, Oklahoma. The company's No. 1 Moyer was drilled to a total depth of 6203 ft, with the Second Wilcox sand topped at 6196 ft. The new well flowed 240 bbl of oil in 24 hours through 1/64-in. and ¾-in. chokes with 88,000 cu ft of gas a day and continuing to test.

Drill Kansas Field Wells

Cities Service Oil Company has completed 3 new gas wells in the Hugoton field of Morton County, Kansas. They are the company's Loether A, which was completed for an open flow of 17,400,000 cu ft, Parker B for 12,100,000 cu ft, and Burton B for 6,710,000 cu ft.

Warren Extends Reef Pool

The Sharon Ridge Canyon reef pool in Scurry County, West Texas has been extended one-half mile to the north by Warren Oil Corporation. The company's F. M. Addison No. 1 well on official potential flowed 2064 bbl through a 1-in. choke in 24 hours with a gas-oil ratio of 924 cu ft a barrel. This was a natural flow without the use of acid.

North Dakota Test Fails

Phillips Petroleum Company has announced abandonment of the North Dakota wildcat, No. 1 Dakota, in Norton County. No indications of commercial oil recovery was encountered at a total depth of 7790 ft. Only a slight stain was found between 4912-22 ft.

Mississippi Field Well

Humble Oil and Refining Company has completed a 1 mile south extension to the East Yellow Creek field of Wayne County, Mississippi. It is the company's No. 1 Mrs. J. B. Mayfield, which pumped on initial tests at the rate of 166 bbl of 16.4 gravity oil per day. Production is from Stanley sand perforations at 4598-4603 ft.

New Mexican Well May Be Important New Discovery

Discovery of a new oil field in the Tehuantepec Isthmus area of Mexico was announced by Ralph K. Davies, president of American Independent Oil Company. The discovery well, known as Rabon Grande No. 1, is located about 5 miles east of the City of Coatzacoalcos in the State of Tabasco and present indications are that it will flow at a rate of 200 to 250 bbl daily of 32.5 gravity oil.

"Further production tests are underway," Davies said, "and additional drilling will be required before the significance of the strike can be fully appraised but this appears to be a distinctly important discovery." A second well is scheduled to be spudded in immediately.

New Well in Texas Field

Plymouth Oil Corporation has brought in a new well in the Pembrook field, Upton County, Texas. The well is situated in the Sprayberry sand, and is known as Greathouse No. 1. It flowed 162 bbl of oil in 24 hours through a ⅜-in. choke, and was drilled to a total depth of 6952 ft. It is Plymouth's first well in the Pembrook field, where it owns 640 acres.

New California Well

Richfield Oil Corporation has completed a new well in the Kern County, Coles Levee field, California. The new well is producing at the rate of 222 bbl daily of 33.4 gravity crude oil through a 14/16-in. choke. It was drilled to a depth of 9433 ft.

Crude Analysis Described

The method by which the Bureau of Mines has made thousands of analyses of hundreds of different crude oils on a comparable basis is described in detail in a bulletin released by Secretary of the Interior Oscar L. Chapman. The necessary equipment also is described and illustrated. Known as the Bureau of Mines routine method, the procedures described in the new bulletin, No. 490, have been standard not only with the Bureau, but with a number of other Government agencies and with oil companies since it was first described in Bulletin 207, issued in 1922 under the title, "The Analytical Distillation of Petroleum and Its Products." The new bulletin describes the equipment and procedures used in the routine method of making crude oil analyses.

Bulletin 490 may be obtained from the Superintendent of Documents, United States Government Printing Office, Washington 25, D. C., for 50 cents a copy.

New Sand Opened In Louisiana Field

A new oil sand has been opened in the north flank of the Valentine field, Lafourche Parish, Louisiana. The well, the No. 3 South Coast Corporation, flowed 306 bbl of 43.7 gravity oil daily through a 9/64-in. choke from 12,798 to 12,824 ft. Tubing pressure was 6400 lb and gas-oil ratio was 5948 to 1.

Okahoma Well Promising

The Texas Company has good prospects for a successful well at its No. 1 Smith in Garvin County, Oklahoma. On drillstem test from 7021-57 ft, with tool open 40 minutes, the operator had gas in 2 minutes, estimated at 3,640,000 cu ft. The well then flowed 64 gravity condensate in 10 minutes at the rate of 10 bbl per hour through a ⅝-in. top hole choke. When operator pulled tool, he recovered 125 ft of 64 gravity condensate, and 120 ft of oil cut mud, and is drilling ahead at 7128 ft.

Shell Completes Two Wells In Elk City Oil Field

Shell Oil Company has completed two good gas and oil producers in the Beckham County, Oklahoma, sector of the prolific Elk City field. The company's No. 2 Fender "B" flowed 532 bbl of 61.3 gravity condensate in 24 hours through a 22/64-in. choke. It is plugged back to 10,011 ft.

The other well is the No. 2 Beck, which flowed 505 bbl of 60.9 gravity condensate oil in 24 hours through a 22/64-in. choke. The well has a plugged back depth of 10,117 ft.

Production of the Fender was from perforations between 9675-9700 ft and between 9725-9810 ft. Gas-oil ratio was 5750 to 1. The Beck was producing from perforations between 9560-9610 ft and between 9650-9710 ft. Its gas-oil ratio was 9481 to 1.

New Well in Waterloo Pool

Ashland Oil and Refining Company has completed another producer in the Southeast Waterloo pool of Oklahoma County, Oklahoma, with its No. 2 Walter Wilson. The new well flowed 56 bbl of load oil with 109 bbl of new oil in 15 hours through ½-in. choke. Hole was drilled to 5991 ft. Open hole was treated with Hydrafrac.

Sun Producer Completed

Sun Oil Company has completed a new producer in the Fox-Graham pool of Carter County, Oklahoma. It is the company's No. 6 Davis, which flowed 70 bbl of oil in 24 hours through ¼-in. choke at plug back depth of 3951 ft. Hole was carried to 4340 ft.

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EXPLORATION ACTIVITIES

Two Wildcat Wells Are Completed in Wyoming

General Petroleum Corporation has completed two exploratory wells in Wyoming. Its exploratory outpost well, Slick Creek No. 22-2-G, in the Big Horn basin district has been completed flowing at the initial production rate of 762 bbl daily of 34.4 degree crude oil through a 7/8-in. bean. The well was drilled to a depth of 10,523 ft.

General Petroleum's other exploratory well, Tip Top No. 4X-12-G, in the Green River basin district, was completed flowing and has present production of 146 bbl daily of 60 deg oil.

Discovers New Mexico Pool

A new Delaware sand pool has been discovered near Carlsbad, New Mexico. Discovery well is Southern California Petroleum Corporation's Valley Land No. 1, which has been drilled to a total depth of 2776 ft for an excess of 100 bbl a day of 52 deg gravity sweet oil. The new pool is in Eddy County.

Prolific Discovery Seen For Martin County, Texas

Pan American Production and Forrest Oil Company's No. 1 F. D. Breedlove may prove to be an important flush discovery in northwest Martin County, Texas. On drillstem test at 12,074-138 the well had an oil flow in 49 minutes. On an hour gage, it tanked 45 bbl of oil with gas-oil ratio 267 to 1. The well first showed for a discovery in flowing 18 bbl of oil an hour on a test at 12,078-98 ft. Second test at 10,070-118 got a 40-bbl per hour flow.

Sinclair Well Competed

Grant County, Oklahoma, is scene of Sinclair Oil and Gas Company's No. 1 Hyder Mulkey, which has opened a new Wilcox sand pool. The wildcat is about 1½ miles south and east of the Rich Valley pool. The new well topped the Wilcox sand at 5793 ft and on drillstem test between 5798-5820 ft, total depth, with tool open 56 minutes, it had gas in 4½ minutes, mud in 28 minutes, and oil in 32 minutes. It flowed 42.3 gravity oil at a rate of 30 bbl an hour with 2,000,000 cu ft of gas a day. Recovery was 1080 ft of oil and 180 ft of muddy oil.

West Texas Leases Sell At Near-Record Prices

Near-record prices were paid for mineral leases on the University of Texas lands in West Texas. Bonus payments totaled $5,651,550 on 148 tracts in Andrews, Martin, Crane, Upton, Crockett, Irion, Pecos, and Hudspeth counties. Magnolia Petroleum Company paid a $1,280,000 bonus for drilling rights on 2389 acres in Andrews County, location of several oil fields. The company is required to drill a well to 5500 ft within 6 months. Other oil companies also paid high bonuses for drilling rights.

Kansas Well Opens Pool

A new Kansas pool opener has been completed in Saline County by E. K. Carey. The well is the No. 1 Oberg, which made 1186 bbl daily on draw down test. It produces from Viola lime, after being drilled to 3416 ft total depth. A mile north of the Ryding field, and a mile west of nearest producing production in the Smolan field, it has been listed tentatively as opening the Ryding North pool.

Carter Well 21 Miles From Other Production

Carter Oil Company is continuing tests at its No. 1 Garrett in Beckham County, Oklahoma. The new discovery, which is 21 miles from other production, is thought to be a forerunner of further extensive development in the area. A packer test of casing perforations at 10,290-295 ft with well open 12 hours filled 2790 ft of oil. Latest reported test was of perforations at 10,280-285 ft, in which the well flowed by heads approximately 20 bbl of oil over a 12-hour period. Gas was at the surface within 22 minutes after the well was opened. By swabbing, the well yielded 35 bbl in 8 hours. Fluid stands at 7500 ft. Gravity of the oil is 40 deg.

Texas Venture Success

Transcontinental Oil Corporation has reported its first successful wildcat venture in Archer County, Texas. The new well is the company's Hemmi No. 1, which came in at a rate of 240 bbl of oil a day. The firm expects a discovery allowable of 120 bbl a day for 30 days over an 18-month period. The same allowable is expected for the first five wells on the field.

Amerada to Drill North Dakota Tests

Amerada Oil Petroleum Corporation has announced that it has applied for permission to drill two new wildcat exploratory tests in North Dakota where it recently found that state's first oil well. The first one will be the No. 1 Bakken, which will be about 12 miles north of the No. 1 Clarence Iverson. The No. 1 Iverson, after producing 47 to 50 gravity oil from 11,630 to 11,660 ft was killed, and is now being deepened below 11,730 ft. Both tests are in Williams County, in the heart of the Williston Basin, a structural feature that takes in western North Dakota, eastern Montana, and part of western South Dakota, as well as part of southern Manitoba in Canada.

Oklahoma Producer Seen

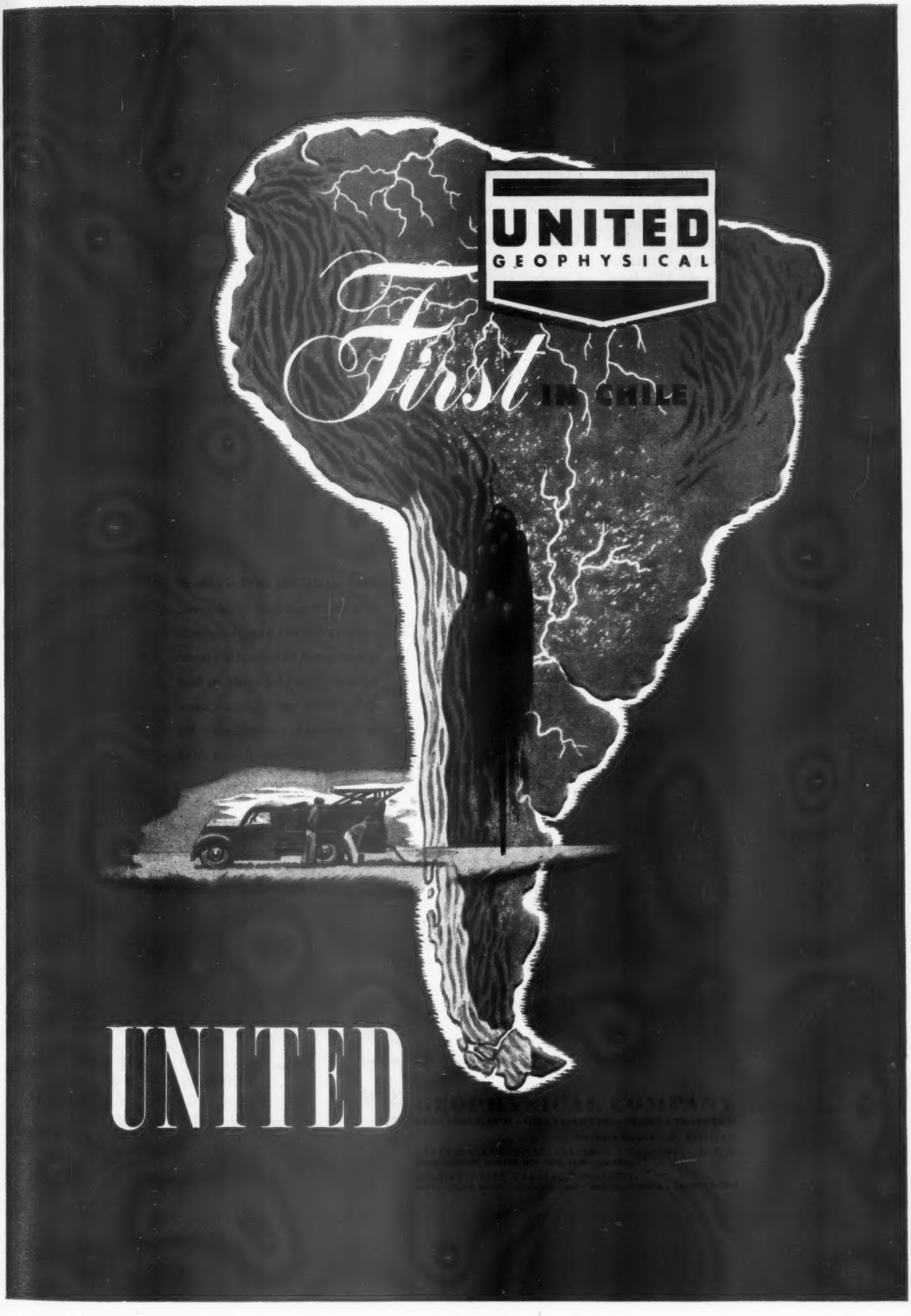
A good producer is assured at Crow Well Servicing Company and Jack Reese's No. 2 A. L. Pippen in Choctaw County, Alabama. Latest gage showed the well pumping at the rate of 186 bbl of 20 gravity oil per day based on a 12-hour test during which the well pumped 93 bbl of oil. Production is being obtained from saturated oil sand in the "A" sand zone of the Eutaw formation, which was perforated with 104 shots at 3894-3912 ft.

Florida Wildcat Drilling

Drilling has begun at a wildcat venture in Collier County, southern Florida. Humble Oil and Refining Company's No. 1 Collie Corporation is the test. Operator has set 20-in. conductor pipe at 115 ft, 13⅜-in. conductor pipe at 115 ft, and surface casing at 1036 ft and at latest reports was drilling ahead below 2800 ft.

Tests for Geologist Set

The United States Civil Service Commission has announced a geologist examination, for filling positions throughout the United States, at yearly salaries ranging from $4600 to $7600 a year. No written tests will be given applicants for the geologist examination. To qualify they must show that they have had appropriate college education or a combination of appropriate college study and experience. In addition, they must have had professional experience in geology.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Exploration Program Set For British Columbia

A $300,000 exploration program in which more than 20 oil and gas firms will take part, has been set for the Lone Mountain area of northern British Columbia, about 50 miles south of Dawson Creek. Initial drilling is to begin immediately. The program will be the largest gas and oil exploration ventures to be undertaken in British Columbia, covering 750,000 sq miles.

Organizations participating in the pool and syndicate, or both, through grants of cash and land are: Allenbee Petroleums, Pacific Petroleums, Calvan Petroleums, Cardinal Petroleums, Ltd., C. C. Cross & Company, Alberta, Ltd., Consolidated Cordasun Oil, Ltd., Edvan Petroleums, Freehold Corporation, Hargal Oils, Jupiter Oils, Kroy Oils, Lone Mountain Oil Development Co., Lone Mountain Murray River Syndicate, Monkman Pass Oil Company, Monkman Syndicate, Royal Canadian Oil, Spooner Oils, Totem Petroleums, Trans Empire Oils, Western Petroleum Leases, Ltd., and Wilrich Petroleums.

Canadian Wildcat Drilled

A three-zone discovery has been reported in a wildcat about 5 miles southwest of the current producing limits of the Leduc oil area in Canada. The Texaco Exploration Company and McColl-Frontenac Oil Company, Ltd., found D2 Devonian oil at their Wizard Lake wildcat, a well that had previously discovered Viking sand gas and Lower Cretaceous oil. Hole will be carried down to the D3 Devonian equivalent in the 4th zone.

Deep Wildcat Drilled in Grady County, Oklahoma

The No. 1 Mainka-Ring in Grady County, Oklahoma, has been completed for a flow of 217 bbl of oil, no water, in 24 hours through a ½ in. choke with gas flow of 1,136,000 cu ft. The Gulf Oil Corporation and Skelly Oil Company well was drilled to 13,651 ft originally, but has been plugged back to 12,280 ft.

Utah Well Successful

The A. K. Wilson wildcat in Iron County, Utah, has found oil in the Moenkopi. The well is the State No. 1, situated on the east flank of San Rafael swell on a surface high. The Moenkopi was topped at 1751 ft, and a saturated sandy lime was found between 1967-69 ft. The Salt Lake City operator bailed 7 bbl of 23 gravity oil per day from the zone.

Colorado Pool Opened

A new pool in Logan County, Colorado, has been opened with Plains Exploration Company's wildcat well there. The new well flowed on test between 5235-51 ft in the "J" sand. It is situated 3½ miles south of Yenter.

Wyoming Tests Planned

Mountain Fuel Supply Company has announced its plans for drilling a test well at Grizzly Buttes in southwestern Wyoming in an effort to increase its supply of natural gas. The company has been authorized by the Utah public service commission to increase the rates it charges consumers so that it will have funds to finance drilling of new test wells.

Geophysical Publications Deposited in S. M. U. Library

The Dallas Geophysical Society has contributed initial funds for purchase of geophysical publications to be deposited in Fondren Library on the campus of Southern Methodist University in Dallas, Texas, according to Robert M. Trent, director of the SMU libraries.

The SMU library has been chosen as the official depository for geophysical publications that will be made available to geophysicists of the Dallas area. Thomas R. Shugart, geophysical consultant, is president of the Dallas Geophysical Society, a local section of the Society of Exploration Geophysicists.

Kansas Well Brought in

A new oil and gas well has been brought in in Seward County, Kansas, for a show of 55,523,000 cu ft of gas daily. The well is the J. M. Huber No. 1 Agnes Feese, about ½ mile southeast of the Light field. Observers said the distillate showing with the gas in the new Huber well indicated it would deliver about 89 bbl of distillate daily when produced at the 25 per cent rate allowed under gas proration. The well is producing through perforations at 5942-68 cut in the top of the Mississippian. Bottom hole pressure was reported as 1580 psi.

New Oil Pool Seen For Oklahoma Area

A new oil pool seems evident for Pauls Valley, Oklahoma, where Harry H. Diamond, Inc., and Fleet Drilling have tested oil in the basal Pennsylvania. Their No. 1 Cleve Dixon, ran a 1-hour test at 3412-44 ft to show gas at once at an estimated 2-3 million cu ft daily, and sprayed oil and mud in 30 minutes. Oil spray cleaned up and was estimated at 3 bbl per hour. Tester was pulled to recover 600 ft of 40-gravity oil and 270 ft of salt water.

Illinois Well Testing

The Gilliam Drilling Company's No. 1 Fitzgerald in Franklin County, Illinois, has set pipe in the Cypress sand at 2528 to 2538 ft. Total depth is 2980 ft. A 2-hour drillstem test recovered 260 ft of free oil, 90 ft of oil cut mud, and no water. It is one-half mile from other oil wells.

B-A Drills Colorado Well

The British-American Oil Producing Company's Monroe No. 1 wildcat in Logan County, Colorado, has been completed for 135 bbl per day. Production is from the Graylon formation, D sand at 4888-4894 ft.

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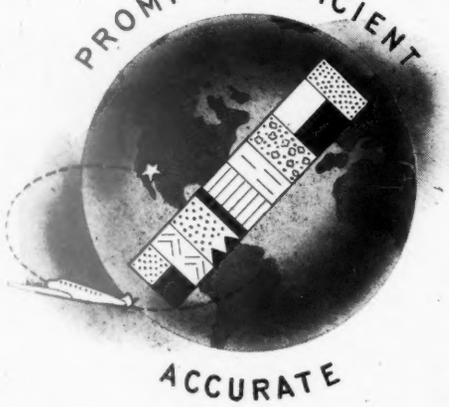

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Running tour with men in the industry

L. E. Fitzjarrald, general superintendent, Phillips Petroleum Company, has been appointed manager of the production department; **H. H. Kaveler,** assistant to the vice president, has been appointed assistant manager, and **J. M. Houchin,** assistant general superintendent, has been appointed general superintendent.

C. P. Dimit, vice president and director of Phillips, will continue as vice president in charge of production.

Fitzjarrald, who joined Phillips in 1919, has been general superintendent since 1944. He has served in the production department since 1922, when he was appointed chief clerk. Kaveler joined the company in 1936, as assistant section chief in the production department.

Houchin joined Phillips in 1933. He has served continuously in the production department, having been appointed assistant general superintendent in 1944. He is a graduate of the University of Oklahoma.

James F. Ormond, production department field engineer for the Sunray Oil Corporation, Midland, Texas, was recently awarded the National Safety Council's President's Medal. Ormond will be awarded the medal by the Medal Administration Committee of the Council for successfully applying artificial respiration to a fellow workman, Kenneth D. Mullings, who inadvertently came in contact with an electrical wire carrying 12,777 volts of electricity while working on a West Texas lease near Odessa.

Karl C. ten Brink, former instructor at Rice Institute who has been with The Texas Company since 1947, has been promoted to assistant director of producing research, Bellaire laboratories, of the company. He is a graduate of Rice Institute and holds the B. S., M. A., and Ph. D. degrees in chemical engineering. He was an instructor at Rice from 1940 to April 1943. Ten Brink joined The Texas Company in 1947, as a chemical engineer at Bellaire.

Dale Benedict, Oklahoma and Mid-Continent landman since 1925, was named assistant manager of Deep Rock Oil Corporation's land department succeeding **L. M. Swayze,** recently resigned. He attended the University of Oklahoma, then began land work in the Southwest with Tide Water Associated Oil Company.

Douglas Ragland, engineer - in-charge, petroleum engineering division, Humble Oil and Refining Company, has been appointed chief petroleum engineer during Bowman Thomas' tour as assistant manager.

T. J. Fuson, division petroleum engineer, Gulf Coast division, became assistant chief petroleum engineer, replacing Ragland. **H. M. Crause, Jr.,** assistant division petroleum engineer, Louisiana division, replaced Fuson as division petroleum engineer of the Gulf Coast division.

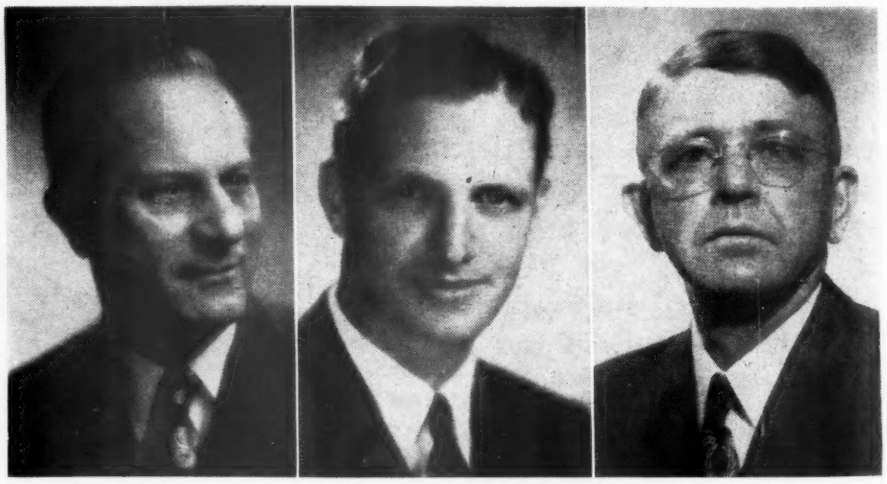
Joe F. Homer, supervising petroleum engineer, was named assistant division petroleum engineer, Louisiana division, to replace Crause.

W. F. Barrett, district superintendent, Government wells district, will serve temporarily as assistant division superintendent of the Southwest Texas division, replacing McCarty.

William A. Castille, assistant division civil engineer, Louisiana division, transferred to the civil engineering division, Houston office, for work as senior supervising engineer during the absence of **L. O. Zapp.** Zapp is on leave for a government assignment.

Richard J. Lee, senior petroleum engineer, Houston office, was transferred to the Willamar district, Southwest Texas division, as district petroleum engineer.

E. T. Mace, toolpusher, moved from the Paradis district, Louisiana division, to the Palestine district, East Texas division.



R. C. Barbour | Bowman Thomas | R. R. McCarty

R. C. Barbour has been appointed manager of Humble Oil and Refining Company's production department. In his new position he will be active head of all production operations, reporting to the director in charge, C. E. Reistle, Jr.

At the same time there were created two training positions to be occupied by assistant managers. These posts will be filled for the present on a rotating basis on tours of one year each, the announcement said. **Bowman Thomas,** former chief petroleum engineer, will be assistant manager in charge of all staff organizations of the department. **R. R. McCarty,** who has been assistant division superintendent in Southwest Texas, will head drilling and producing operations.

As part of the training program, **Douglas Ragland** will become chief petroleum engineer. He was formerly assistant chief petroleum engineer.

Barbour joined Humble in 1921 as a lease oil pumper. In 1923, he became district superintendent of the Powell oil field. In 1946 he became general superintendent of the production department.

Thomas joined Humble as a junior petroleum engineer in 1929, shortly after graduating from the University of Oklahoma. In January 1940 he was promoted to assistant chief petroleum engineer and in March 1945 he was named chief petroleum engineer in the company's production department.

McCarty, a graduate of Louisiana State University, began his career with Humble as a student engineer in 1930. In 1946 he was appointed assistant division superintendent of the Southwest Texas division, with headquarters at Corpus Christi. He has held that position until his recent promotion in Humble's company training program.

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Fox, Oklahoma. You get more types of guns, more sizes of bullets, and the maximum safe charge of explosives in small pipe, where MORE POWER is needed. In this particular well, 4½" drill pipe was set due to the scarcity of casing. Ordinary jet perforators could not do the job, due to the small charge of explosives necessary in a small O.D. rigid body gun. The McCullough Glass Jet Perforator with a Steel Strip Carrier permitted the use of the maximum safe charge of explosives, resulting in a successful gas well.

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To obtain more information on products advertised see page E-33

▸ **James R. Puckett** has been promoted from district petroleum engineer of Magnolia Petroleum Company's Kermit producing district to division petroleum engineer of the Kansas - Illinois - Kentucky division with headquarters at Wichita, Kansas. Puckett replaces **John R. Van Slyke,** who went into business for himself.

H. K. Holland has been promoted from assistant division petroleum engineer of Magnolia's Gulf Coast division at Houston to division engineer of the Oklahoma division with headquarters at Oklahoma City. He replaced **Henry L. Waszkowski,** who has been made assistant superintendent of the Healdton producing district.

Dee F. Pendley, Jr., has been promoted from a petroleum engineer of the Kermit district to district petroleum engineer of Magnolia's Electra producing district.

Robert W. Lewis, Jr., has been promoted from district petroleum engineer of the Falfurrias district to assistant division petroleum engineer of Magnolia's West Texas division with quarters at Midland, Texas.

Robert C. Randle has been promoted from a petroleum engineer of the Falfurrias district to district petroleum engineer in the same district.

Ollie J. Ford, Jr., district petroleum engineer of Magnolia's Rusk producing district in East Texas, has been transferred to the same position in the Kermit producing district.

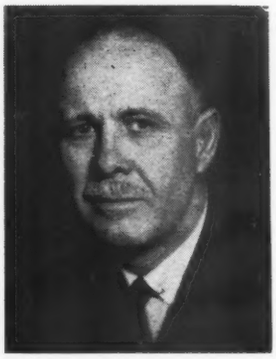
Joseph A. Morris has been promoted from a petroleum engineer in the Alice producing district to district petroleum engineer of Magnolia's Rusk producing district with headquarters at Kilgore, Texas.

▸ **V. M. Grant,** assistant division supervisor of industrial relations, Oklahoma division, producing department, The Texas Company, has been promoted to division supervisor of industrial relations, Rocky Mountain division, and transferred to Denver, Colorado.

He will replace **S. F. Chamberlin,** who has been recalled into military service as a Captain in the U. S. Air Force. Chamberlin has been supervisor of industrial relations in the Rocky Mountain division since June 1, 1948.

Grant is a graduate of Northeastern State Teachers College, Tahlequah, Oklahoma, and was employed by The Texas Company in the Oklahoma division offices at Tulsa in 1937. Succeeding Grant at Tulsa will be **E. L. Taylor,** head payroll clerk of the Oklahoma division. He is a graduate of Tulsa University and has been with the company since 1939.

Paul W. McFarland



Frank O. Prior

▸ **Paul W. McFarland** has been advanced to the position of assistant chief geologist for Sun Oil Company's Southwest producing division, with headquarters in Dallas, Texas.

He will continue as regional geologist in charge of the San Antonio, Corpus Christi, and McAllen districts, a position he has held for a number of years.

McFarland attended the University of Kansas, finishing there in 1921. He joined Sun in 1923, and served about two years in Venezuela. On his return to the United States, he worked briefly at Tulsa, Oklahoma, before going to Laredo, Texas, in October, 1925. He spent two years there and a similar period at San Antonio before joining the Dallas office in 1929.

▸ **Frank O. Prior,** vice president in charge of production, a member of the executive committee, and a director of Standard Oil Company (Indiana), has been elected executive vice president by the board of directors.

Prior joined Midwest Refining Company, a former subsidiary of Standard Oil Company (Indiana), in 1919 as a roustabout in the Salt Creek field of Wyoming. He was made president of Stanolind Oil and Gas Company in 1930, when the company was formed through a merger of Dixie Oil and other producing subsidiaries of Standard of Indiana to carry on oil producing operations.

In 1945 Prior was elected a director and vice president of Standard. He attended Stanford University.

S. M. Gladney

Tom F. Hill

▸ **Sam M. Gladney** has been named manager of Sun Oil Company's Southwest producing division. Assistant manager of the division since 1947, Gladney succeeds **J. H. Pressley,** who has relinquished all managerial and official capacities with Sun because of prolonged absence from company activities due to continued illness. Pressley has been with Sun since 1905. Succeeding Gladney as assistant manager will be **Tom F. Hill,** who has been regional land superintendent since February 1, 1950.

Gladney joined Sun Oil Company in 1919 as a clerk in the accounting department at Dallas. In 1930 he became district land superintendent at Tyler, Texas. He returned to Dallas in 1939 as manager of the land department, a position he held until his promotion to assistant manager of the Southwest division in 1947. He was recently elected an assistant secretary of Sun Oil Company.

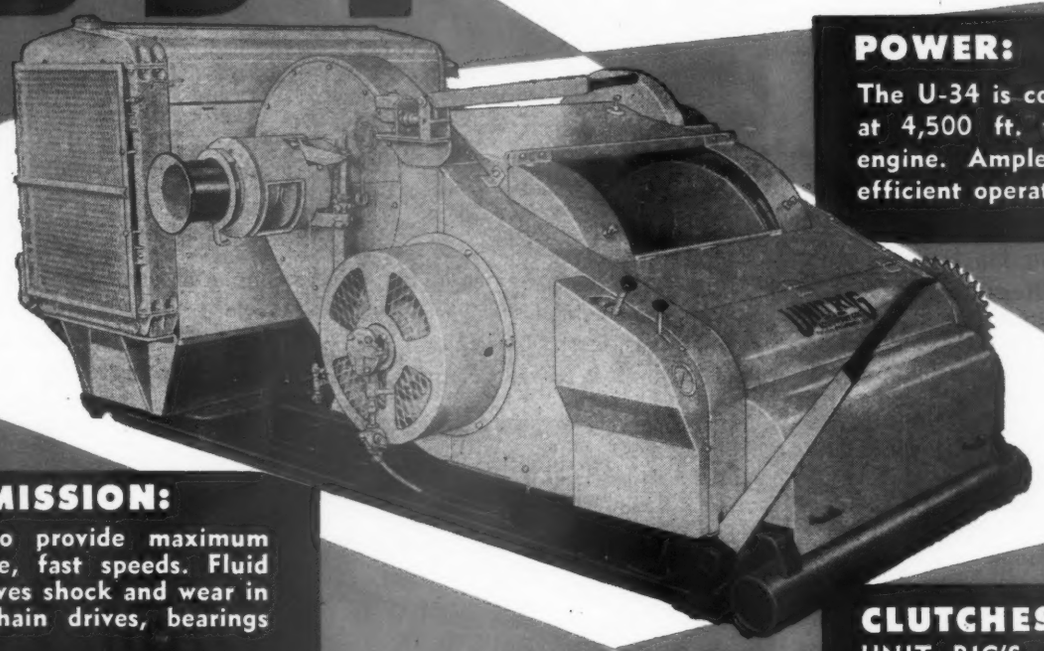
Hill joined Sun Oil Company 20 years ago as a sample washer in the paleontology laboratory at Dallas, working part time while still a student at Southern Methodist University. He became assistant district land superintendent in 1946. Two years later he was named a division landman at Dallas, and last year became assistant to Gladney.

▸ **Leo A. Castler** has been advanced to the position of project engineer in the engineering department of General Petroleum Corporation. Castler, who came with the company in 1943 as a senior draftsman, will report directly to A. K. Brumbaugh, Jr., engineer of design, at the company's Vernon, (California) offices. He is a graduate of University of California.

▸ **Lee Stedman,** Pure Oil Company scout from Tyler, Texas, has been named president of the National Oil Scouts and Landsmen's Association in Beaumont, Texas. **Le Roy Francis, Jr.,** Jackson, Mississippi, was elected first vice president. Others chosen were **Dave Ridgway,** Casper, Wyoming, second vice president; **R. L. Denton,** Midland, third vice president; **E. T. Hall,** Calgary, Canada, secretary-treasurer. Hall is the first Canadian ever to hold office in the association.

U-34

CUT COSTS on shallow well drilling. . .



POWER:
The U-34 is conservatively rated at 4,500 ft. with a 275 H.P. engine. Ample power for fast, efficient operation and long life.

TRANSMISSION:
Designed to provide maximum pull at safe, fast speeds. Fluid coupling saves shock and wear in clutches, chain drives, bearings and line.

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▸ **R. I. Williams** has been named assistant general superintendent of crude oil production for Lion Oil Company. Williams, who is completing his thirteenth year in Lion Oil's production department, moves up from the post of superintendent of the Southern division.

A. W. Wood, recently with Phillips' production department, has been employed to succeed Williams. In this capacity he will supervise the company's oil and gas production operations in Louisiana, Mississippi, South and East Texas, and South Arkansas (with exception of the Shuler Unit).

Wood majored in petroleum engineering at Oklahoma University and Tulsa University, joining Phillips in 1936.

▸ **R. G. "Dick" Reese,** chief of exploration for Arctic Contractors, has joined Hudson's Bay Oil and Gas Company, Ltd., as chief geologist.

Reese received his degree in geology at the University of Nebraska in 1923. His earlier assignments included field geological work in Mexico for two major oil companies and as a geologist and a petroleum engineer for another major oil company in the California fields.

Hudson's Bay Oil and Gas Company, Ltd., is the operating affiliate in Canada of Continental Oil.

▸ **Samuel T. Coleman** has been named manager of the land department of Deep Rock Oil Corporation, filling the position vacated recently by the resignation of **F. E. Swenson.** Coleman has had 13 years' experience in all phases of land work in the Midwest. He received his L. L. B. degree from the University of Oklahoma in 1938.

Swenson, who had been with Deep Rock since 1947, resigned to become president of the State Lands Exploration Company at Midland, Texas.

▸ **Dave C. Garrett,** former toolpusher for General Geophysical Company's drilling operations in Indiana, Illinois, and Kentucky, has been named district superintendent for the company's operations in the 3-state area. He succeeds **Paul A. Whitney.** Headquarters for the company's operations in this area have been moved from Mt. Vernon, Illinois, to 203 Indiana Bank Building, Evansville, Indiana. Toolpushers for General Geophysical drilling operations in the area are R. N. (Nick) Minear and K. P. (Kenny) Clark.

Dave C. Garrett

New members inducted into the Los Angeles chapter of Nomads are: C. Edward Van Loozen, Web Wilson Oil Tools; Robert Gaylord, Wagner-Morehouse, Inc.; E. B. Fowkes, Emsco Derrick and Equipment, who inducted the new members; Paul Bowen, S. R. Bowen Company, and Dante Syracusa, S. R. Bowen Company.

Speaking before the L. A. Nomads' recent gathering were: Florent H. Bailly and Gilberto Capriles. With them is Walter Elliott, Jr., Santa Fe Drilling Company.

Venezuela, U. S. Relations Discussed at Nomads' Meet

Florent H. Bailly, Petroleum Engineering Associates, Inc., Pasadena, and Pantepec Oil Company, Venezuela, discussed U. S. relations with Venezuela at a meeting of the Los Angeles chapter of Nomads recently.

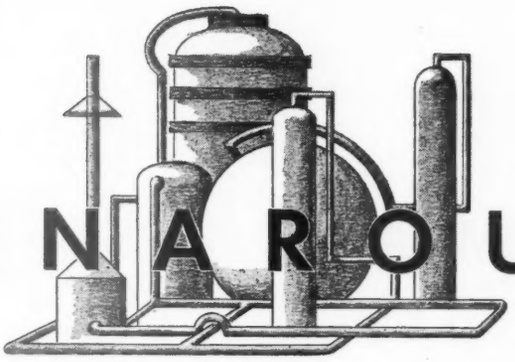
He pointed out that oil can be used as a bond in Western Hemisphere solidarity. By examining our ideals and their ideals, we can find a meeting ground for common understanding, common substance, and aspirations, Bailly declared, adding that the oil situation in the Middle East makes it more essential than ever that a united Western front be attained.

Consul Gilberto Capriles of Venezuela, with 16 years of foreign service for his country, in Austria, Mexico, and now Los Angeles, described the physical and geographical features of his country as compared with other nations. Senor Capriles gave a detailed picture of the resources of Venezuela, which holds real promise for the years to come.

Murray Walker, just returned from a trip for Lane Wells throughout Latin America, gave a capsule picture of business possibilities in each of the South American nations. The general conclusion was that business is good and will be much better later in the year, particularly in Brazil, Columbia, and possibly Peru.

▸ **Burr M. Roberts,** senior geologist in charge of Bishop Oil Company operations in Alberta Province, Canada, is being transferred to the United States to carry out new exploratory assignments. The company also announced that **R. Ross Anderson** has been appointed assistant manager of its Canadian branch office in Calgary.

THE TURNAROUND



WHENCE OCTANE NUMBERS?

PERHAPS the greatest progress in modern times in the development of mechanical power has been and still is the result of the cooperative development work of the oil refining and the automotive building industries. "Passing the buck" rather continuously each to the other, these two industries have advanced the power, flexibility, and economy of the automotive engine-hydrocarbon fuel combination from a thermal (brake) efficiency of about 28 per cent at a compression ratio of 8-to-1 to a value of nearly 32 per cent at 12-to-1. During the last 20-year period the miles-per-gallon of cars on the road has increased from about 15—at 40 mph—to an average of about 19.5 in 1950, or more than 30 per cent. At the same time average engine horsepower has increased from less than 75 in 1930 to nearly 120 in 1950 models. Obviously, economy has not been sacrificed to the God Performance. Gasoline price has risen only slightly in the interim.

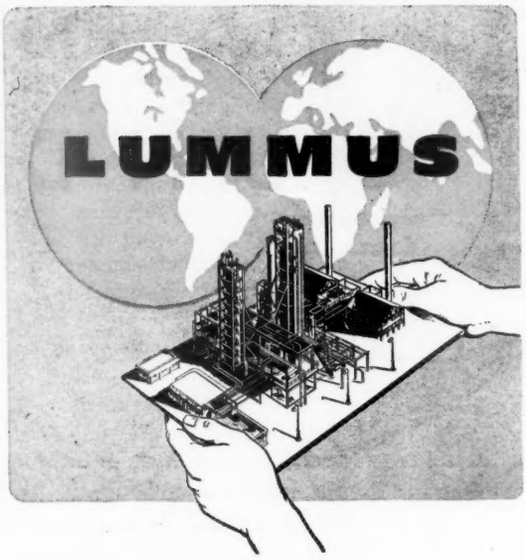
This development is traceable to two major trends, improvement in the octane rating of fuels, which in regular grades rose from about 60 in 1930 to about 84 in 1950; and improvement in engine design, in so-called "mechanical octane numbers" by the automotive industry, to enable the engine to operate more efficiently without knock on lower octane ratings than was the case at any earlier time. As time goes on, the two industries are faced with the need to answer properly the all-important questions: Which is the less expensive and the more efficient, chemical or mechanical octane numbers? How much of the required fuel-engine improvement can be attained best by the one system, how much by the other?

The attainment of chemical octane number improvement requires change in molecular structure. Mechanical octane number improvement means numerous, often radical, changes in the innumerable details of engine design. Neither method of advance is simple; each requires endless experiment.

General Motors and other automotive research groups, the great number of oil refining research establishments are progressing rapidly in working out some of these details. C. L. McCuen stated before the API in May that to attain in production cars the 12-to-1 compression ratio used in present experimental engines means another 30 per cent efficiency increase for the two industries' products; that this will save U. S. motor drivers $2½ billion per year in fuel cost, saving 10½ billion gallons of motor fuel annually, or the annual fuel consumption of 15,000,000 cars, nearly 1/3 of our present estimated 48,000,000 cars, trucks, buses. This of course means a corresponding extension of our crude reserves, or of our ability to supply fuel needs from present crude consumed.

These figures projected on a national basis are of the most fundamental importance in our national and world economy. How shall this efficiency be attained? Plainly, both chemical and mechanical octane numbers must each be utilized to the greatest possible extent; bi-industry collaboration is the only way to find out how much one way is to be used, how much the other.

Fuel injection offers some interesting possibilities, and various outfits, such as Texaco's experimental engine, have shown some far-reaching results. This aid to "mechanical" or to "chemical" octane numbers must not be overlooked; likewise the high natural octane rating inherent in propane and butane, huge production of which is practicable. A. L. F.



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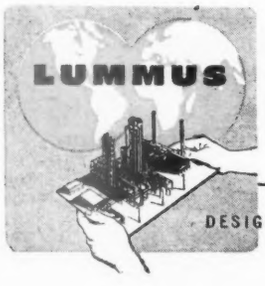
But wherever you see it, it symbolizes a project in capable hands—Lummus hands. It stands securely on its world-wide record—the designing and constructing of nearly 200 units of all types for the manufacture of motor gasoline, high octane aviation fuel, and fuel oils . . . more than 115 lube oil and wax processing plants . . . over 300 units for making chemicals and petroleum chemicals . . . and a score of complete refineries and chemical plants.

It's a good sign to look for, believe in, and rely on when you buy complete, integrated engineering service for *your* next project.



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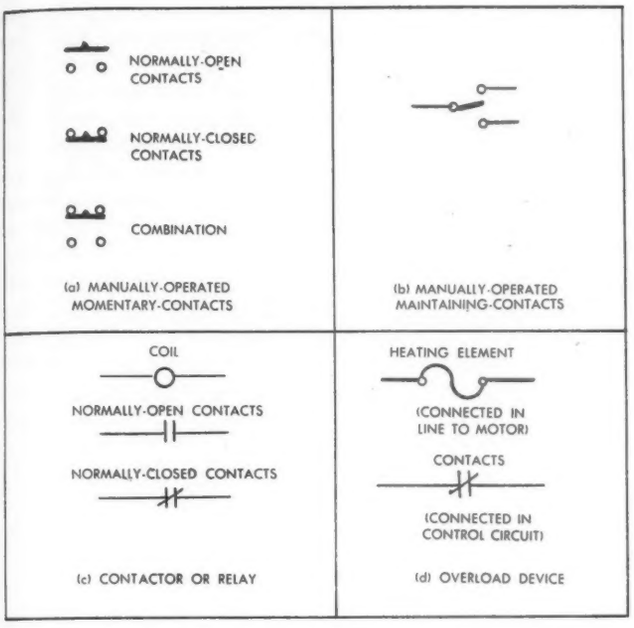


FIG. 1. Device symbols.

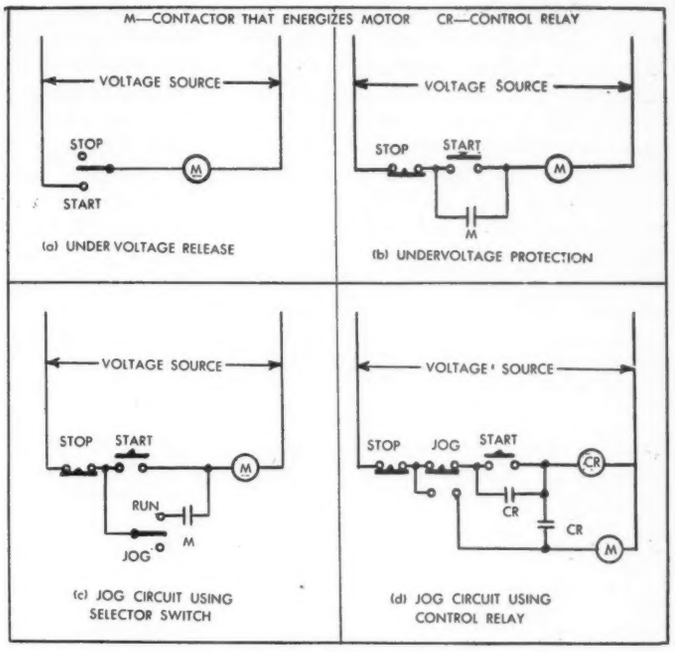


FIG. 2. Starting and stopping circuits.

Selection of Electric Motor Controls

A large factor in satisfactory operation of any motor in a refining or gas processing plant is choice of proper controls

JOE BENISH*

THE selection of motors for various applications in the processing industry was considered in a previous article. Before discussion of the factors involved in the selection of control for these motors, one important point should be stressed. That is the fact that the two subjects are inter-related. Proper control equipment can be selected only after thorough consideration has been given to the type of motor that is to be controlled. In addition it is well to give proper thought to the type of control that may be available for a given class of motor, and include these findings in the final decision as to just which motor is to be used. It is only through such a simultaneous study of motors and control that proper coordination can be obtained for a complete system, regardless of whether the prime consideration be functional or economic.

The most common components encountered in control applications are symbolized in Fig. 1. Parts (a) and (b) of this figure are symbols for manually-operated switches. Momentary-contact devices are those that make contact when pushed and break contact when released. Maintaining-contact switches are those that remain in either the open or closed position until actuated by the operator. These symbols normally apply whether the devices are pushbuttons, master switches, toggle switches, or other manually-operated switches.

The symbol for either a magnetic contactor or relay is shown in Fig. 1 (c). Either of these devices is merely an electromagnetic assembly arranged to move or "pick up" an armature or clapper when the coil of the magnet is energized. The clapper carries or operates contacts which in turn perform the various control functions. These contacts are designed as "normally open" when they are open in the de-energized position of the device, and "normally closed" when they are closed in the de-energized position. Essentially, the difference between a contactor and a relay is the amount of current each is capable of carrying. A relay is used to interrupt only small amounts of current, its contacts being located exclusively in the control circuits. A contactor, on the other hand, handles current in the power circuit and must be capable of interrupting the current carried by the motor that is being controlled.

Fig. 1 (d) indicates the symbol used for an overload relay, the construction and operation of which is discussed under a later heading.

*Assistant professor of Electrical Engineering, Texas A&M College.

EXCLUSIVE

Basic Control Circuits

In order to be in a position to properly select control equipment for an application, a basic knowledge must be attained of what primary functions contactor. The motor then coasts to a how these functions are controlled. The simplest control circuits, as might be expected, are those used merely to start and stop the motor in question. The most fundamental of these circuits are shown in Fig. 2. In each case the manual device, usually a pushbutton, is designated by function (start, stop, etc.).

Fig. 2 (a) illustrates the simplest type of starting circuit, commonly known as "under-voltage release." The motor is started by throwing the maintaining-contact pushbutton to the "start" position. This causes the contactor "M" to pick up. Contacts on "M" complete the circuit to the motor allowing the motor to start. As a rule, the voltage used to pick up the contactor is the same as that eventually applied to the motor. Thus if the voltage on the system drops to a level that would prove damaging to the motor, the contactor drops out, stopping the motor until such time as the voltage returns to a normal level. The contactor then restarts the motor. When it is desired to stop the motor, the switch is thrown to the "stop" position. In this case, as in all subsequent cases, the pushbutton may be situated at a position remote from the motor.

As there is often the necessity to include a great number of motors on the same voltage source, the first circuit is sometimes undesirable. Should the voltage drop to a low value, all motors on the system would stop. Then, with a return of voltage, all motors would attempt to start simultaneously. The starting current of all these motors would overtax the system, resulting in failure in one form or another. This can be prevented by the use of the circuit of Fig. 2 (b). In this circuit the pushbutton is of the momentary-contact type. When the "start" button is pressed, the circuit to the contactor coil is completed. The contactor picks up, closing the normally-open contacts, which are connected across the "start" button contacts. This "seals in" the contactor. At the same time the motor is started. With a failure of system voltage, the contactor drops out, opening the normally-open contacts. Should the voltage return, however, the contactor will not pick up until the "start" button is pressed again. Thus it is possible to manually control the restarting of the motors, insuring sufficient time between the starting of various motors to allow one to come up to speed, with the corresponding great decrease in current below that required on starting, before another motor is started.

In a number of applications it is desirable to make a provision in the control whereby the operator can start the motor for an instant, then immediately stop it. A circuit providing this feature is termed a "jogging" or "inching" circuit. Fig. 2 (c) and (d) show typical jogging circuits. The first incorporates a "run-jog" selector switch. If the switch is thrown to the "run" position, normal undervoltage protection is obtained. If the switch is thrown to the "jog" position, it is possible to start and stop the motor simply by depressing, then releasing the momentary contact "start" button. Thus jogging is secured.

Fig. 2 (d) illustrates a safe type of jogging circuit using a momentary-contact "jog" button. To start the motor for normal operation, the "start" button is pressed. The control relay, "CR", picks up, latching in through its contacts across the "start" button. The other contacts of the control relay also close, picking up the contactor, which starts the motor. Undervoltage protection is secured through the control relay. For jogging operation, the "jog" button is momentarily pressed. This picks up the contactor directly, releasing it as soon as the "jog" button is released. At the same time, there is protection against misoperation as "M" cannot latch in through the jog circuit, nor the start circuit, due to the open contacts of the control relay.

Reversing circuits are usually two separate starting circuits, one for either direction of rotation of the motor. As on either d-c or a-c controllers, however, severe short circuits would result in the event that both the forward and reverse contactors were closed at the same time, special precautions must be taken. A common means of preventing this is to mechanically interlock the contactors by means of an arm that prevents closure of both contactors at once. In addition to this, electrical interlocks are usually provided as shown in Fig. 3 (a). A normally-closed contact on the reversing contactor is placed in series with the coil of the forward contactor. Thus the coil of the forward contactor cannot be energized until the reversing contactor is in its open position.

If a motor is running in one direction and the leads are reversed to cause the motor to tend to turn in the opposite direction, this process is termed "plugging". While the circuit of Fig. 3 (a) allows plugging, many motors cannot stand to be plugged frequently, and many cannot stand to be plugged at all. This is dependent not only upon the motor, but upon the inertia of the motor and load. One of the most frequent uses of plugging is found on applications in which it is desired to stop a motor in the shortest possible length of time. For this purpose plugging switches are available. These are centrifugally-operated switches attached directly to the shaft of the motor. The contacts can be made to close above a certain speed and open below that speed. This speed is usually a low one in comparison to the rated speed of the motor. Fig. (3) (b) shows a typical circuit using a plugging switch to stop a motor. Starting of the motor is as usual, the normally-closed contact on the forward contactor preventing operation of the reverse contactor. Pressing the "stop" button releases the forward contactor, closing its normally-closed contacts. Because at this time the speed is normal, the plugging switch contacts are closed. Thus the reversing contactor picks up. The speed of the motor decreases very rapidly. As soon as the speed drops below the present value, the plugging switch contacts open, releasing the reversing contactor. The motor then coasts to a stop.

The circuit of Fig. 3 (c) provides plug-stop operation at the option of the operator. Should normal coasting to a stop be desired, the operator presses the "stop" button enough to cause the forward contactor to drop out. Should he instead desire to plug the motor to a stop, he can press the button all the way in, closing the contacts in series with the plugging switch, and causing the reverse contactor to pick up. Operation is then the same as obtained from the previous circuit.

A large percentage of control equipment is required to be at least partially automatic in its operation. While a complete coverage of the multitude of control functions that can be obtained with various pilot devices is out of the question, a few possibilities are shown in Fig. 4. In each case, the pilot device could be any one of the many devices on the market actuated by mechanical, thermal, pressure, or other means.

Fig. 4 (a) indicates a circuit that combines undervoltage protection with the use of a pilot device to secure stoppage of a motor. For instance, assume the pilot device is a pressure switch. If the pressure drops to a certain level, the pressure switch contacts close. At any time after this closure, the operator may start the motor-operated pump by pushing the "start" button. The motor will con-

tinue to run until the contacts of the pressure switch open. The contactor is then de-energized, the motor stops, and operation cannot resume even after the pressure switch contacts close again unless the operator again pushes the "start" button.

Fig. 4 (b), on the other hand, is a circuit utilizing a maintaining-contact "manual-stop-automatic" switch to secure either completely automatic or completely manual operation. Fig. 4 (c) illustrates a circuit that combines completely automatic control with undervoltage protection.

Protection of Motors

Basically, protection of motors can be divided into two distinct categories; overload protection and short circuit protection. Of the two, the first is actually protection for the motor itself. Primarily, the second is protection for the wiring to the motor and protection for the various control equipments associated with the motor, although at times it functions to protect the motor also.

The National Electric Code specifies the use of overcurrent devices intended to protect the motors, auxiliary control equipment, and current-carrying conductors. It specifies that these devices " . . . shall be rated or set at not more than 125 per cent of the motor full-load current rating for motors marked to have a temperature rise not over 40 C, and at not more than 115 per cent for all other types of motors".

Overload protection is usually secured either thermally or magnetically. Thermal overloads are the most common. They usually consist of a bimetallic strip mounted in such a fashion that its deflection when hot opens a set of electrical contacts. These are placed in the various control circuits already discussed, usually in series with the "stop" button. As a result, the motor is stopped any time the bimetallic strip becomes excessively hot. On some thermal overloads, the bimetallic strip itself carries the current to the motor. A more common arrangement, however, is to provide a separate "heater", mounted adjacent to the bimetallic strip. This heater can be constructed to generate the required amount of heat due to any one of a range of currents. Thus by substituting a different heater, an overload device can be made to operate on any required current.

Another fairly common overload is the magnetically-operated type. This utilizes a magnetic solenoid, set to pick up on the required current. As it is not desirable to stop the motor due to a momentary overload, this device must be damped by some means, whereas the heat transfer necessary in the thermal device automatically causes the desired lag in time. Dashpots are often used to obtain the time lag for magnetically-operated overloads.

In order to properly protect a motor, an overload device must be capable of tripping on any excessive current between the rated tripping current and the stalled current of the motor, in a time less than that which will cause damage to the motor at that current. Fig. 5 shows a typical heating curve for an induction motor, indicating the length of time it takes to reach a dangerous temperature for various values of current. In addition are shown typical overload device tripping characteristics.

Possible damage to a motor due to over-currents has as its immediate cause the temperature created by these currents. As a result, the past history of the load current is important, since

FIG. 3. Reversing and plugging circuits.

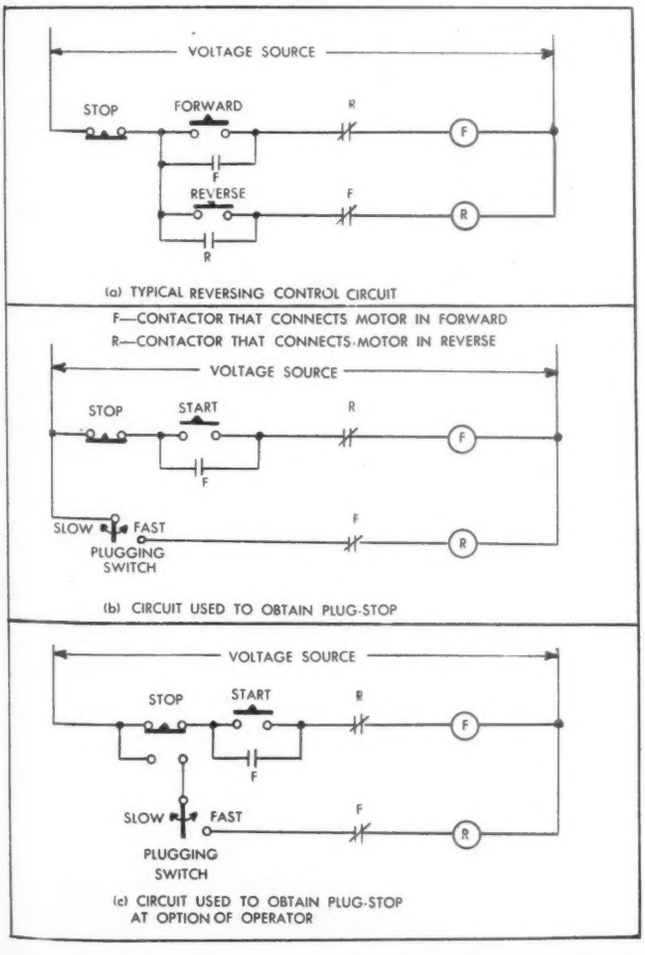


FIG. 4. Circuits using pilot devices to secure automatic control.

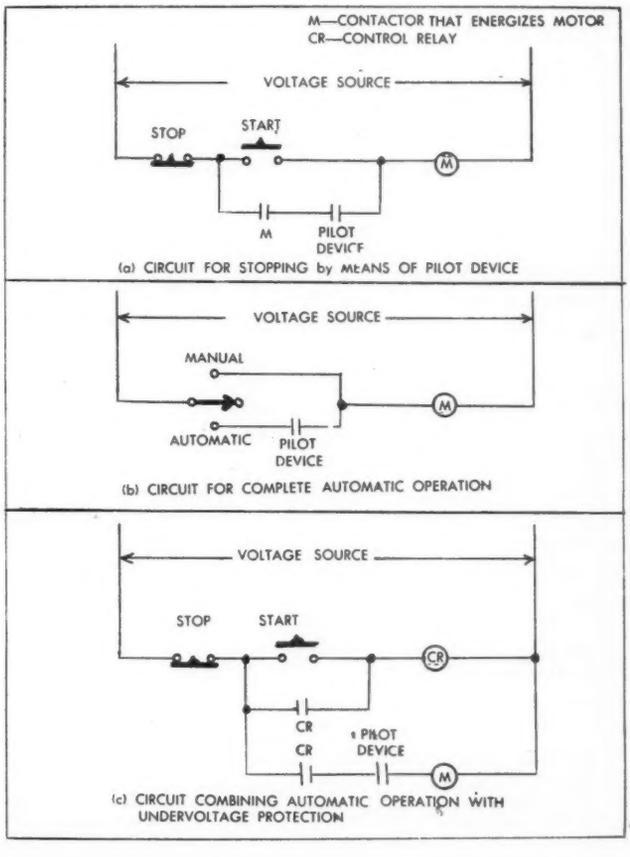
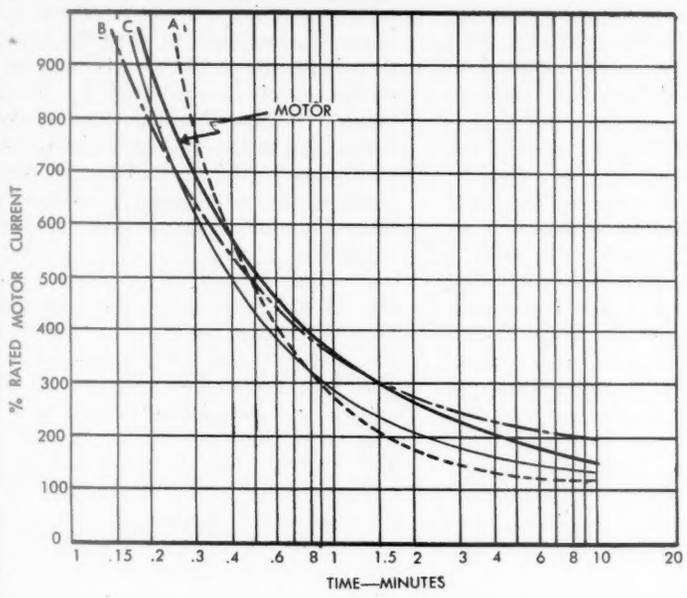
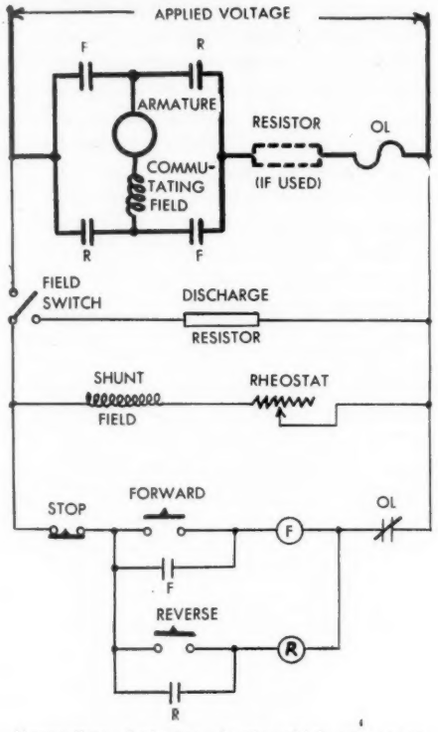


FIG. 5. Time-current characteristics for typical motor and overload devices.



Time for motor is elapsed time at a particular current before excessive heating occurs.
Time for overload devices is elapsed time at a particular current before device trips.
Curve A indicates an overload device which would protect the motor on prolonged overload.
Curve B indicates an overload device which would protect the motor on stalled conditions.
Curve C indicates an overload device which would protect the motor on both conditions.

FIG. 6. Typical d-c motor reversing controller.



Heavy lines designate circuits which must carry large currents.
F is forward contactor.
R is reverse contactor.
OL is overload device.

the motor, being rather large, dissipates its heat slowly in comparison to most overload devices. Thus many overload devices will protect a motor sufficiently when both are started cold. Yet these same devices, particularly if they have tripped several times and have been reset immediately by the operator, will cease to prevent heating in the motor after a prolonged period of operation. Added to this is the fact that the controller housing the overload device is often situated remote from the motor, and in a much lower ambient temperature. So, while the overload might continue to have the proper current-time characteristic, it might easily allow the motor to be damaged due to excessive heating. Most of these disadvantages can be remedied by proper selection of overload current ratings, although the proper rating to protect the motor may sometimes prevent operation of the motor under full load conditions.

In addition to overload protection, branch circuit overcurrent protection (often referred to as short circuit protection) for motors is specified by the National Electric Code. Tables specifying current settings for devices used to give this form of protection are listed in the Code as a function of the type of motor and the starting KVA per horsepower of the motor. In addition the Code specifies that these devices should in no case be set for more than 400 per cent of the motor full load current. They must, however, be set above the starting current of the motor.

In general, short circuit protection takes two basic forms. The first of these forms is that of a simple disconnect switch used in conjunction with fuses. The second is that of a manually-operated circuit breaker, usually provided with both a thermal and an instantaneous magnetic trip. Each of these is sanctioned by the National Electric Code, so long as it meets with the current requirements set forth in the tables.

In reality, both types of short circuit protection often leave something to be desired when they are applied to the protection of motor circuits. Standard lines of fuses and circuit breakers were designed primarily for the purpose of protecting wiring alone. Thus, when called upon to protect not only the wiring, but the motor controllers and motors, their characteristics are not as desirable as would have been the case had they been designed specifically for this type of application.

☆ ☆ ☆

Refinery runs this year are averaging about 1000 bbl a day higher than in the same period last year. Demand has been so high that stocks have decreased from 86 to 72 days' supply.

Control of D-C Motors

As a rule, control for d-c motors is required to perform more functions and is therefore more complex than that for a-c motors. This is due to the fact that the usual applications of d-c motors utilize the variability of the motor's speed. This, of course, must be handled by the controller. In addition, the necessity to provide a means to insert resistances in series with the armature to limit the starting current makes the control more complex.

A typical d-c motor control circuit, incorporating reversing, is shown in Fig. 6. The control portion of the circuit operates as already outlined. This circuit is sufficient for only relatively small d-c motors, ½ hp or less as a rule. For larger motors it is usually necessary to provide one or more steps of acceleration. This may be done in several ways, one of which is

shown in Fig. 7. This method of acceleration is based upon the fact that the greater the speed of the motor for a given field current, the greater will be the voltage across the armature. The coils of the accelerating contactors are connected across the armature of the motor. The contactors "1A" through "4A" are set to pick up on successively higher values of voltage. Thus as the motor comes up to speed, the segments of resistance in series with the armature are shorted out one by one until full voltage is applied across the armature, at which time the motor is running at full speed.

The use of automatic control finds one of its most advanced uses in the control of speed of d-c motors. Hundreds of applications require a variation of the speed of a motor by an operator located at a position remote from the motor itself, a fact which immediately suggests a magnetic controller. By proper consideration of the operating characteristics of the motor, it is possible to work out a scheme to accomplish virtually any program of speed variation. Resistors can be inserted in series with the d-c motor armature, in parallel with the armature or series field, or in many combinations of these connections in order to secure the proper speed-torque relationships as discussed in the previous article on motors. The necessary resistors are usually included as a part of the controller, which is situated near the motor whenever possible. Thus maximum efficiency is gained with a minimum of power wiring. Due to the extreme number of possibilities available with this type of control, it would be hard to show a typical circuit for the variation of speed. For these circuits, reference should be made to the various manufacturers in order to gain an idea of the number of types available.

Control of A-C Motors

The control for a squirrel cage induction motor, like the motor itself, is relatively simple. The most common functions performed by control for these motors are starting, reversing, and speed changing. Although by far the greatest number of applications allow a squirrel cage motor to be started by throwing it directly on the line, it is sometimes necessary to start the motor with reduced voltage. This is accomplished by the use of starting resistances, reactors, or auto-transformers. Fig. 8 (a) shows a starting circuit using auto-transformers.

Reversing of the three phase, squirrel cage induction motor is accomplished by interchanging any two leads to the motor. Fig. 8 (b) illustrates a controller that performs this function. And finally, changing speed is accomplished by reconnecting the leads to the motor to change the number of poles of the motor. For this purpose, a circuit similar to the reversing circuit is used, the reversing contactor being instead a pole-changing contactor.

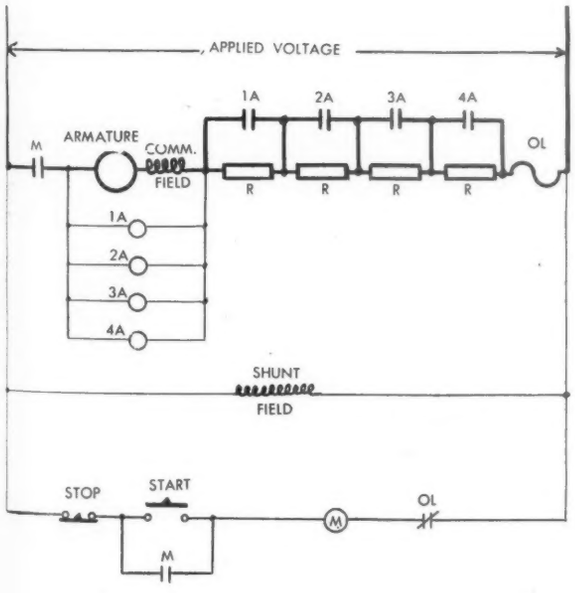
Variation of the speed of a wound rotor motor is done by means of resistances inserted in the rotor circuit. Although, this is often accomplished by the use of a drum switch, the same type of control as used on d-c motors can be applied. The resistor arrangement, however, is such that three phase balanced resistors are inserted in the rotor circuit. This makes possible the control of a wound rotor motor from a position remote from the motor, eliminating the bulky and often hard-to-handle drum switch.

The control for synchronous motors is similar to that used for squirrel cage induction motors with the additional necessity to provide a means to apply field current to the d-c field at the proper instant when starting the motor. This feature alone has made most of the better controllers for synchronous motors fairly complex. The simpler controllers utilize a timing relay to apply field current after a given length of motor accelerating time. Other controllers use the variation of reactance in the field winding as the motor comes up to speed as an indication to relays as to when field current should be applied.

Actuating Devices

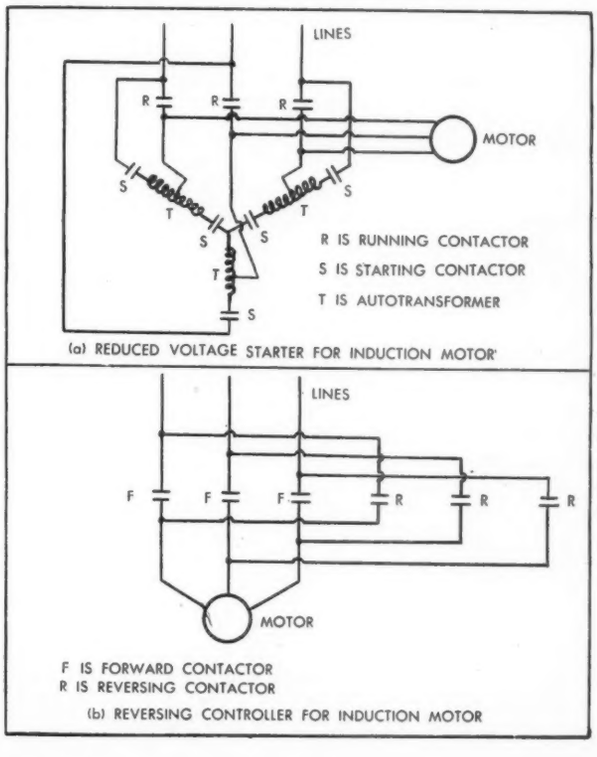
In order that any control equipment be made automatic, an actuating device must be used. As has been shown, these actuating or pilot de-

FIG. 7. D-c accelerating controller.



M is contactor used to connect motor to line
1A, 2A, 3A, and 4A are accelerating contactors.
OL is overload relay.
R is starting resistor.

FIG. 8. Induction motor control circuits.
(Control circuits similar to those for d-c.)



vices can be placed in the control circuit of a controller in the form of electrical contacts. These electrical contacts are sometimes a part of the pilot device and are sometimes a part of a relay, which in turn is caused to operate by means of the actuating device. In the case of some actuating means, it is necessary to introduce several conversions before it is possible to utilize the device to control a motor. For instance, a photoelectric tube would require an electronic amplifier, which in turn would cause a relay to operate.

A portion of the wide variety of actuating devices is listed in Table 1. Manufacturers of the various devices should be consulted as to the characteristics and available ranges for any particular device.

TABLE 1. Actuating devices.

Actuated by	Forms of device	Characteristics, typical arrangements, etc.
Operator	Pushbutton	Momentary, maintaining, or latched type contacts. Any number of individual units mounted as a group.
Operator	Master switch	Often of the camswitch type with any number of separate control circuits.
Operator	Drum switches	Similiar to master switches except that power switching contacts are included.
Physical displacement	Limit switches	Control length of linear travel, angular displacement, or total number of revolutions.
Physical displacement	"Micro-switches"	Same as limit switches except capable of detecting and controlling movements of a few thousandths of an inch.
Physical displacement	Piezo-electric crystals	Movement against a crystal causes a voltage to appear across crystal.
Temperature	Thermocouple	Thermocouple's voltage is dependent upon the temperature.
Temperature	Temperature sensitive resistor	Resistance changes with temperature.
Temperature	Expansion bulbs	Liquid expands with temperature.
Pressure	Diaphragm, bellows, or bourdon tube	Pressure converted directly to mechanical displacement.
Pressure	Liquid column	Level of liquid in column dependent upon pressure.
Liquid level	Float switches	Float level converted to mechanical displacement.
Liquid level	Capacitor	Dividing line between air and liquid when both are used as dielectric in capacitor varies capacitance.
Fluid flow	Fluid motor	Velocity of rotation dependent upon rate of fluid flow.
Fluid flow	Orifice, pitot tube	Indicates pressure difference.
Strain	Springs	Mechanical displacement proportional to stress applied to spring.
Strain	Variable resistance	Resistance dependent upon stress.
Speed	Electric generator	Output voltage proportional to speed.
Speed	Centrifugal switches	Centrifugal force proportional to speed. Force opens contacts.
Acceleration	Mass & spring	Acceleration causes movement of mass against restraining force of spring.
Light	Photo-tubes	Conductance or electronic emission of tubes is changed by variation in intensity of light striking tube.
Humidity	Moisture sensitive capacitor	Capacitance of air-type capacitor varies with moisture content of air.
Time	Mechanical	Total number of revolutions or oscillations of spring-loaded motor, pendulum, or balanced wheel dependent upon elapsed time.
Time	Capacitor discharge	Voltage across capacitor and resistor during discharge of capacitor is dependent upon time.
Time	Magnetic decay	Length of time required for a magnetic relay to drop out is dependent upon the rate of decay of magnetic flux.

The above table is not intended as a complete list of possible actuating devices. Instead, it is given as a sample of the possibilities.

Special Control Functions

In order that many of the actuating devices may be made to control motor operations, electrical amplifiers often are required. By far the most common and familiar is the electronic amplifier. Hundreds of forms and types are available, the selection of which is dependent upon the required characteristics. Essentially, however, the principle involved is that of converting a small electrical current, voltage, or power input variation into a much larger variation, which is proportional to the input signal. The large output is thus capable of performing functions which require considerable amounts of power, and performing these functions in accordance with the dictates of the signal input. The primary advantages of the electronic type of amplifier are its extremely fast speed response and its ability to operate on extremely low power input levels.

Another type of amplifier often used as a part of motor control is the rotating type of amplifier. This is a specially constructed and connected d-c generator, arranged so that a small variation in field current gives an extremely large variation in output current. Its advantages are its extremely large output power and ruggedness. Its limitations are its requirement of a relatively strong input signal and its slow speed response. The latter is seldom prohibitive when used with motor controls, however, since the motor itself takes a comparatively long time to respond to a change.

Another amplifier type becoming increasingly important in performing control functions is the magnetic amplifier. By saturating the magnetic core of a special transformer by means of a small d-c current in one winding, the reactance of separate a-c windings is caused to vary. This variation in reactance is used, in turn, to vary large a-c currents flowing through the windings, achieving amplification. Actually, the limitations of this device are much the same as those for the rotating amplifier. Its simple construction, however, makes it even more rugged and less expensive.

Another special control device which is constantly finding increasing fields of application is the selsyn system. Basically, at least two motor-like devices are used. In the most common form, both require a single phase, a-c input and a three wire connection between devices. An angular displacement of one, called the transmitter, will cause an equal displacement of the other, called the receiver. Or, rotation of one causes the other to rotate at the same speed, the total number of revolutions of each being the same. Thus a "geared" system is obtained, yet one can be situated at a position far from the other. Selsyns have replaced flexible shafting and complex gearing systems in many applications, since the only necessary conection is a three-conductor electrical cable. Also, the fact that one transmitter can be made to operate any number of receivers has added to the possibilities for using this type of system. The chief limitation to the selsyn lies in its available torque output. Should a large torque be required, it would be necessary to select a relatively large set of selsyns.

Bibliography

1. G. W. Heumann, Magnetic Control of Industrial Motors, John Wiley and Sons, Inc., 1947 (book).
2. P. B. Harwood, Control of Electric Motors, John Wiley and Sons, 1944 (book).
3. E. E. Lynch and A. J. Corson, Primary Detectors for Measurements, Electrical Engineering, September, 1948. pages 849-858.

* * *

Electrolytic Conductivity Measurements

ROBERT TOBI*

THE purpose of this article is to discuss conductivity measurements and their limitations. Such measurements are reliable for estimating the concentration of a single or a predominating substance in a water solution, or for determining the approximate concentration of electrolytic contaminants in relatively pure water. To express the quantity of such impurities as parts per million of solids, or as grains per gallon of chlorine, etc., requires some knowledge of both chemistry and electricity. To gain this knowledge it is necessary to become familiar with the definitions of some of the terms used as well as some of the theories involved.

Theory

Conductivity is a measure of the ability of a material to conduct an electrical current. An electrical current may consist of either the flow of electrons in a metal conductor or the flow of charged molecules or ions in a solution. In process instrumentation electrical conductivity is used to determine the concentration of solutions containing one or more dissolved substances. This discussion is limited to electrolytic conductors.

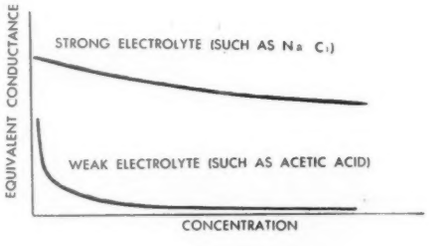
Pure water is a relatively poor conductor of electricity. If an acid, a base, or a salt is added, however, the solution formed becomes a relatively good conductor. This occurs because the added substance splits apart or dissociates in a water solution to form charged particles. These charged particles are called ions, and the process is called ionization.

A Wheatstone Bridge Circuit is used to measure the conductance or the resistance of such a solution, but electrolytes differ from metallic conductors in that the flow of current produces chemical changes in the solution. These chemical changes cause ions to gather at the electrodes. When this happens the electrodes are said to be "polarized," and correct readings cannot be obtained. By the use of an alternating current in the measuring circuit the effects due to polarization can be reduced. At a frequency of 60 cycles per second, the errors due to polarization can be neglected in most cases.

Because a solution conducts electricity in proportion to the total amount of ions present, conductivity is not a measure of any specific ion or substance. Different substances ionize to different extents so the conductivity of a solution cannot be used to determine the actual concentration of a solution unless the substances in solution and the extent of their ionizations are known. Conductivities are purely additive quantities provided no chemical reaction results between the substances when mixed.

For any particular substance the conductance varies not only with the amount of the substance, but with the dilution. As an illustration 50 grams of the substance in a solution may ionize 10 per cent while 25 grams in the same amount of solution would ionize 15 per cent. A chemist would express this by stating that the degree of ionization increases with dilution, and instead of speaking of the specific conductance of a certain concentration of solution of some substance, he would speak of the equivalent conductance at various concentrations and temperatures. Fig. 1 shows how equivalent conductance varies with concentration.

FIG. 1



In addition to the variation of conductivity with dilution, conductivity also varies with temperature.

Limitations of Conductivity Measurements

Some conductivity instruments have scales calibrated in grains per gallon of chlorine. These scales were worked up for the U. S. Navy, and are based on a brine solution having approximately the following constituents:

Na Cl	79.0 per cent
Mg Cl_2	9.8 per cent
Na Br	0.1 per cent
K_2 SO_4	2.5 per cent
Mg SO_4	5.1 per cent
Ca SO_4	3.5 per cent

Any change in the above constituents will cause the scale readings to be in error. If the NaCl and $MgCl_2$ were replaced by an "electrically equivalent" amount of Na_2So_4, the conductivity of the solution could be kept the same; although, there would be no chlorine in the solution.

The same limitations apply to instruments calibrated in parts per million of total solids. It is necessary to know the constituents in solution and make special scales for each case.

Calibrating instruments in units of conductance will stress the fact that the electrical measurements is proportional to the specific conductance of any ions in the solution. Knowing this, much better interpretations of the readings can be made.

If we consider the problem of measuring steam quality, or rather steam purity, by means of conductivity measurements, we find that since only a few parts per million of solids are involved, the problem is not simple. The degree of ionization of weak electrolytes increases in low concentrations (Fig. 1) so dissolved gases and weak electrolytes that are not significant at high concentrations cause a relatively large part of the conductane readings at low concentrations. This would indicate a much larger amount of solids than actually present. At higher temperatures and pressures, it is also possible that the ionization of water itself would change making corrections for the conductance of water necessary.

To properly interpret the meaning of conductivity measurements, it is necessary to decide what is wanted and then decide what factors should be considered, whether to neutralize the water being tested, and whether to remove the gases from the solution. When all of these conditions have been considered, conductivity measurements can be used to control water

*Burke and Reynolds Construction Company.

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conditions and to detect abnormal changes in concentration.

Once this preliminary work has been completed, long and tedious laboratory procedures can be eliminated. For example, continuous conductivity measurements can easily detect changes in concentration of 1 part per million. Such a determination in the laboratory would require the evaporation of about a gallon of water to obtain sufficient residue to accurately weigh the sample.

Facts and Figures Useful in Interpreting Conductivity Measurements

The unit of conductance is the mho. High conductance indicates low resistance while low conductance indicates high resistance.

$$\text{mhos} = \frac{1}{\text{ohms}}$$

One micromho equals one millionth of a mho.

The specific conductance of pure water is about 0.055 micromhos. In determining conductivities of different salts a group of scientists were able to prepare water with a conductivity of about 0.3 micromhos. In a laboratory by taking special care and by removing dissolved gases, water can be obtained having a conductivity of 1 micromho. This indicates that ordinary distilled water may have a conductivity of 2 to 3 micromhos or more. As 1 micromho is equivalent to about 0.6 parts per million of solids in steam condensates, it is seen that ordinary distilled water may have more impurities than good steam condensates. For this reason conductivity instruments cannot be checked in their lower ranges by means of chemical solutions. In these ranges the instruments are more accurate than the solutions can be prepared.

The following figures are only approximate:

1. In boiler waters 1 micromho is equivalent to 0.80 parts per million.
2. In steam condensates 1 micromho is equivalent to 0.60 PPM.
3. One grain per gallon equals 17 PPM.
4. 1.8 grains per gallon of solids are equivalent to 1 grain per gallon of chlorine. (Based on Navy brine, see page 3.)
5. 50 micromhos equal 1 grain per gallon of Cl. (Navy brine.)
6. Steam purity should be less than 5 PPM of solids.
7. Conductivity increases about 2 per cent per °C.
8. Pressure corrections to conductivity are negligible.

Cell Constants and Actual Measurements

Specific conductance or conductivity is the conductance in mhos of a cube of electrolyte 1 centimeter on a side (mhos per mo. cube). The mean effective cross section of the area between actual electrodes cannot be measured mechanically so it is done electrically. An electrolyte is prepared that has a known specific conductance, and the conductance of this solution is measured with the cell or electrodes in question. In this way a constant called the "cell constant" can be determined.

$$K_c = \frac{Ls}{Lm}$$

K_c = Cell constant.
L_s = Specific conductance of prepared solution at temp. T.
L_m = Measured conductance of solution at temp. T.

In checking conductivity instruments it is necessary to be able to determine cell constants. For example, with a cell constant of 0.1, any measurements will yield conductance values 10 times greater than the specific conductance of the solution. Cell constants are affected by the distance between electrodes, their shapes and nature of the electrodes surfaces. Electrode surfaces are platinized to help reduce polarization. Because of this their surfaces must be kept clean and at times replatinized. Complete maintenance instructions for conductivity cells are found in manufacturer's catalogues.

The most reliable method for checking conductivity instruments is to check the instrument by means of resistance coils and to check the cell constant separately. As most of the experimental data on conductivity has been done at 25 C, many instrument scales are now based on a 77 F reference temperature. Some older instruments are based on 100 F. When testing instruments at other temperatures, temperature correction factors must be applied.

References

Betz, John Drew, "Conductivity an Important Control Test." *Power Generation*, December, 1948.

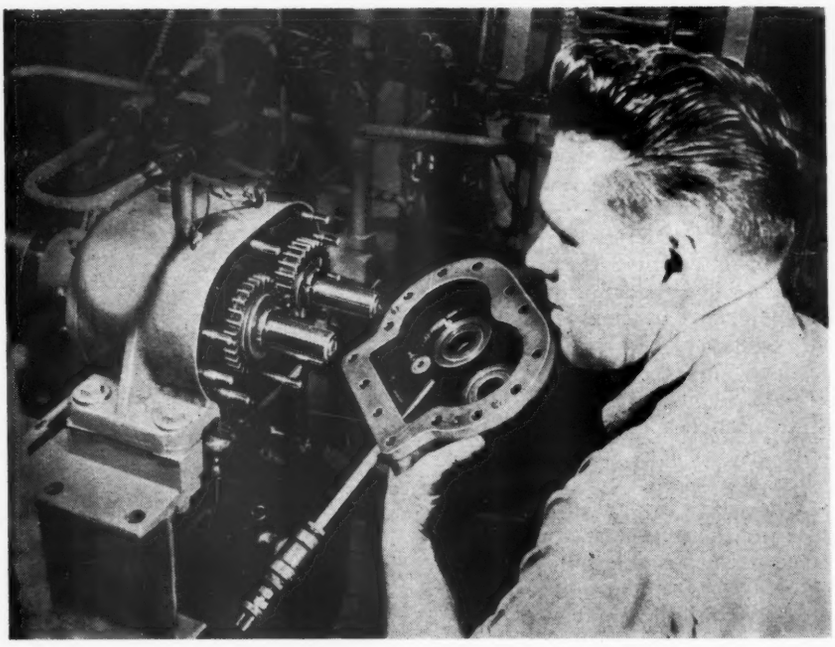
MacDougall, F. H., "Physical Chemistry," Chapter XVI. The MacMillan Co.

Brown Instrument Co., "pH and Conductivity," Catalogue No. 15-12.

Leeds and Northrup Co., "Electrolytic Conductivity Measurements," Catalogue No. EN-95. 1939.

* * *

Lubrication of Gears Under Heavy Loads at High Speed



Gear Tester William Stotesbury of the engineering department of Texaco's Beacon, New York, laboratories assembles a pair of precision gears for a test run. This test was developed by Texaco engineers to study the lubrication needs of gears running at speeds up to 6000 rpm under loads equivalent to 5000 hp. The new lubricants will keep turbine-driven jet planes and locomotives rolling along smoothly. Testing such lubricants in equipment that simulates closely commercial gears in normal operation is imperative if dependable results are to be obtained.

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Charts Simplify Refinery Piping Design

With such details on graphs as pipe line expansion rates, bending and pressure stresses, required U-bends, work is quicker and easier

Most of the piping used in the production, transmission, and refining of petroleum operates at temperatures above atmospheric. Under these conditions, expansion problems are always encountered. Although several means are available for solving usual expansion bend problems, most of them require a series of lengthy calculations which are time consuming during refinery design or alteration. To eliminate as many calculations as possible, a semi-graphical method for solution of the more common expansion bends has been devised. It is sufficiently accurate for all oil, gas, gasoline, steam, air, and water piping used in the distribution systems and process areas of refineries and natural gasoline plants.

Design Charts

The first step in piping system design after selection of a suitable pipe size and wall thickness is computation of pipe expansion. Tables of linear expansion coefficients are available in all handbooks but they are cumbersome to use and require much time, especially when it is necessary to interpolate between successive values. Fig. 1 eliminates page turning and reference to several different books when computing expansion. By using as shown, the linear expansion of all pipes commonly employed in refining operations can be quickly determined. The chart is based on recommendations of the ASA Code For Pressure Piping, B31.1, Section 6, paragraph 620c. Note that linear expansion in terms of inches per 100 ft and the total expansion in inches can be obtained when the operating temperature and pipe material are known.

Allowable stresses in piping within and outside of refinery limits are given in Section 3 of the Piping Code. When the piping system is subjected to occasional temperature changes and minor cyclic variable stresses, the combined stress resulting from bending and pressure should not exceed

$$S_{bp} = 0.75\ (S_A + S_O) \quad . \quad . \quad (1)$$

where S_A = allowable stress at atmospheric temperature and S_O = allowable stress at operating temperature, both in psi. It should be noted that the stress at "atmospheric" temperature is always equal to that at 100 F because the Piping Code does not give stress values at temperatures lower than 100 F. The curves in Fig. 2 permit easy solution of equation (1) for several grades and type of pipe used within and outside refineries. By entering at the operating temperature and projecting across to the proper curve, allowable combined stress is found at the bottom. In no case should the combined stress exceed 40 per cent of the specified tensile stress of the piping material at room temperature.

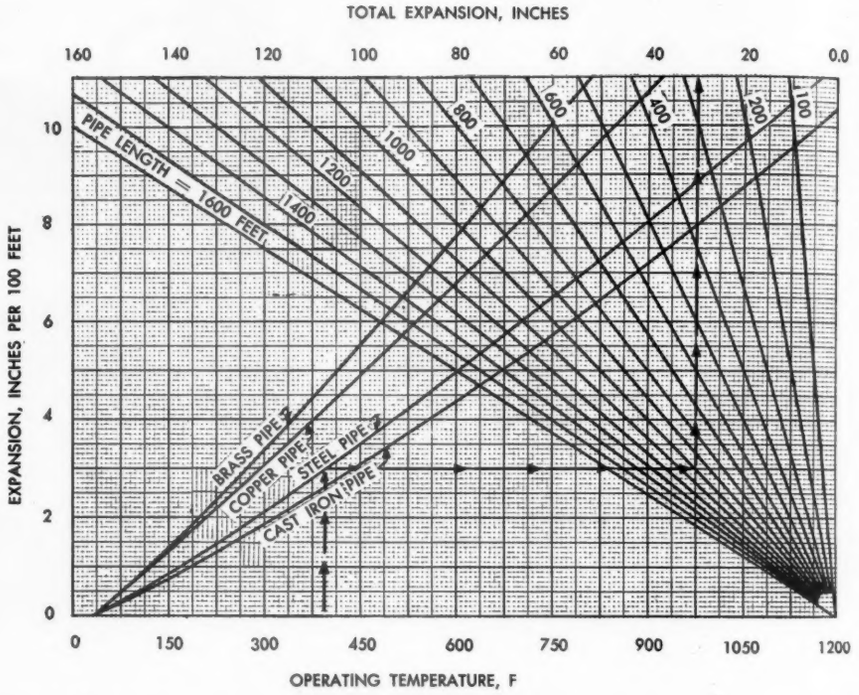

FIG. 1. Chart for determining pipe line expansion. Enter at the operating temperature and project vertically to the pipe material curve. From here run across horizontally to the length curve and then up to the total expansion in inches. If desired, expansion in inches per 100 ft can be read at left.

The longitudinal pressure stress is determined by dividing the end force due to internal pressure

$$F = p\pi d^2/4 \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

by the cross-sectional area of the pipe wall

$$A = \pi/4(D^2 - d^2) \quad . \quad . \quad . \quad (3)$$

in which

p = internal pressure, psig
d = nominal outside diameter of pipe minus two times the nominal wall thickness, inches
D = nominal outside diameter of pipe, inches

The actual allowable bending stress is then found by taking the difference between S_{bp} and the longitudinal pressure stress. Fig. 3 provides a quick means for solving the above relations and is used as shown.

Figs. 4, 5, and 6 are further aids for refinery piping designers. The first two permit rapid determination of the allowable length of plain U bends and double offset U bends when using a known radius and operating at a given temperature. Anchor reactions for

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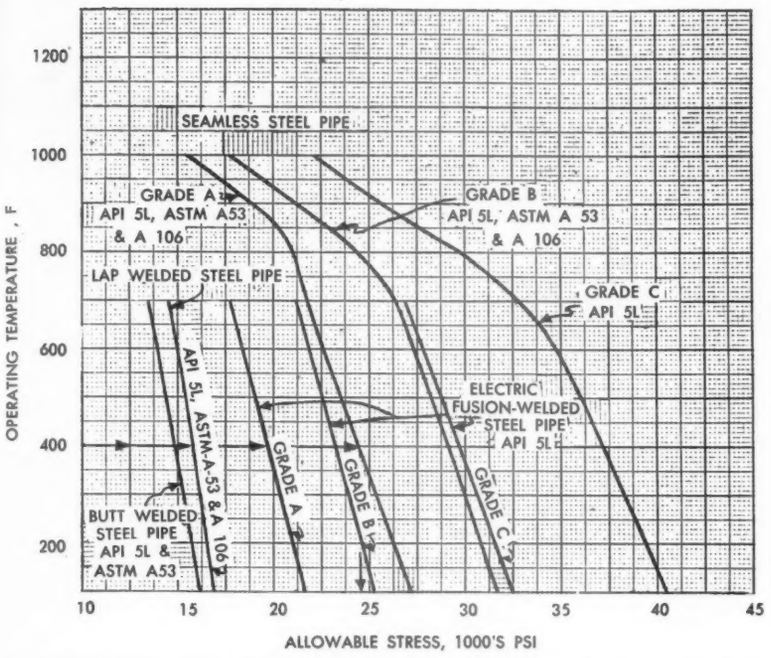


FIG. 2. Allowable combined bending and pressure stress for various grades of pipe within refinery limits. To use, enter at the operating temperature and project horizontally to the pipe material curve. At the bottom, read the allowable stress. For piping outside refinery limits, see Piping Code, Section 3.

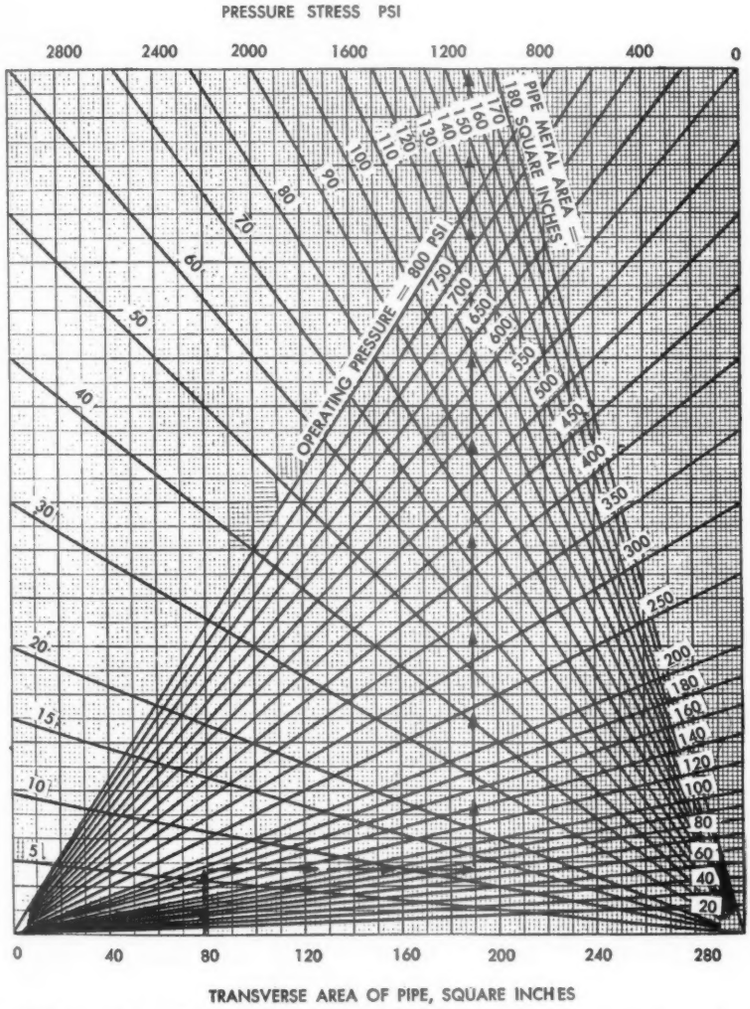


FIG. 3. Chart for determining longitudinal pressure stress in refinery piping. Determine transverse area of pipe and area of metal from a table of pipe properties. Then enter at the transverse area and project vertically to the pipe operating pressure. From here run across horizontally to the metal area curve and then up vertically to the pressure stress.

these bends can be found from Fig. 6. Typical application of the charts can best be shown by an illustrative example.

Chart Use

Problem: A 10 in. Schedule 40 pipe has been selected for a 1000-ft long refinery steam line operating at 165 psig and 400 F. Pipe material is API 5L, Grade A seamless steel. Determine the number of plain U bends, double offset U bends, and the number of slip joints needed to absorb the expansion of this pipe when maximum cold spring is used.

Solution: Enter Fig. 1 at 400 F and project as shown. Total expansion of the pipe is found to be 30 in. on the upper scale. Fig. 2 shows that the allowable stress resulting from bending and pressure at 400 F is 24,500 psi. Longitudinal pressure stress is 1,100 psi, as found from Fig. 3. Allowable bending stress is therefore,

$$24{,}500 - 1{,}100 = 23{,}400 \text{ psi.}$$

The minimum allowable radius for pipe bends used in refineries is generally assumed to be about five times the nominal pipe diameter. It should be noted, however, that a larger radius, 6 to 10 times the nominal pipe diameter, is more desirable both from manufacturing and anchoring standpoints. Hence, a radius of 10 times the nominal pipe diameter will be assumed for the plain U bends and 7 times for the double offset U bends in this refinery steam line.

Plain Bends

By entering Fig. 4 at $d = 10$ in, $R = 10d$, and projecting to the operating temperature, pipe length, cold spring factor, and allowable stress, it is seen that about 2.3 plain U bends are needed. As only a whole number of bends can be used, three are necessary. Each bend will be 1000 ft/3 = 333.3 ft long. The bending stress will be less than the allowable stress because each bend absorbs a smaller amount of expansion — a condition that results from use of a whole number of bends instead of a fractional number. Actual bending stress is found by considering cold spring and chart stresses, as follows.

Use of maximum cold spring in a bend means that 50 per cent or more of the pipe expansion is cut off before the line is sprung into position. Under these conditions the allowable overall length of the bend is 1.5 times that without cold spring. As the bends in this problem were assumed to have maximum cold spring, allowable overall length without cold spring is 333.3 ft/1.5 = 222 ft. This length is based on the working stress in the

pipe, which results from bending and is as yet unknown. From Fig. 4, allowable bend length without cold spring and with a stress of 10,000 psi in the pipe, is 129 ft. Now, the ratio between pipe stress and 10,000 psi is the same as the ratio between 222 and 129 ft. Setting up a proportion,

$$S_a/10{,}000 = 222 \text{ ft}/129 \text{ ft, and}$$
$$S_a = 17{,}200 \text{ psi}$$

This compares favorably with the allowable value of 23,400 psi and the combined stress resulting from pressure and bending is less than 40 per cent of the specified tensile strength of the pipe material. It should be noted that when a fractional number of bends is indicated by the chart, the next larger whole number should always be used. For instance, if 2 instead of 3 bends had been used in this problem, the combined pressure and bending stress would have exceeded the allowable value recommended by the Piping Code.

Anchor reaction is found from Fig. 6 as 2000 lb by projecting as shown. This reaction is based on a bending stress of 10,000 psi. However, actual bending stress is 17,200 psi, as computed above. Therefore,

Anchor reaction =

$$\frac{17{,}200}{10{,}000}\ (2{,}000) = 3440 \text{ lb}$$

Good design would locate anchors as shown in Fig. 7a. Anchors between bends are actually unnecessary during normal operation because forces between any two bends are equal and opposite. Uneven warming of the pipe with resultant unbalance of bend forces makes the use of anchors between bends desirable. They provide for more accurate control of the pipe without materially decreasing flexibility. Anchors must always be used at each end of the pipe to absorb the forces.

Double Offset U Bends

A similar solution for double offset bends, using Figs. 5 and 6 shows the following results. Two bends, each 500 ft long, are satisfactory. Bending stress is 16,800 psi and anchor reaction is 2650 lb. Anchors would be located as shown in Fig. 7b.

Slip Joints

From Fig. 1 it is seen that the pipe will expand 30 in. when operating at 400 F. Double ended slip joints that can absorb up to 24 in. of expansion are available. Assuming use of this type, number of joints, N, needed is,

$$N = 30 \text{ in.}/24 \text{ in.} = 1.25, \text{ or } 2.$$

Cold spring is not used with slip joints because when the pipe cooled it would pull out of the joint. The two joints would be installed between anchors as

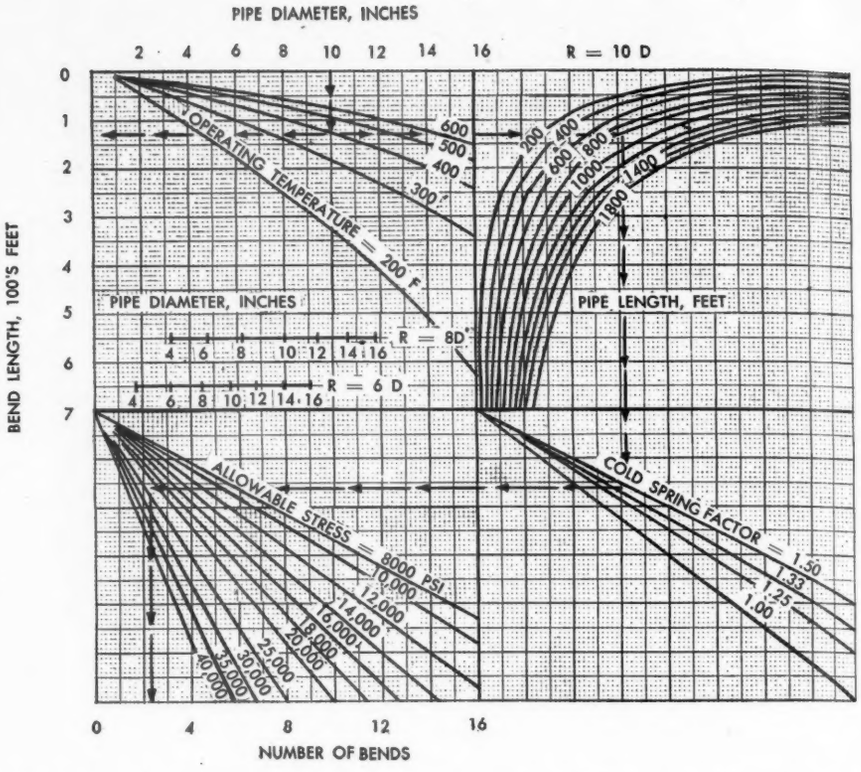


FIG. 4. Chart for finding the number of plain U bends needed to absorb the expansion of a pipe line of given length operating at a known temperature. To use, project from pipe size on proper bend radius scale to the operating temperature. At the left read the allowable distance between anchors or the length of bend for a stress of 10,000 psi in the pipe. Then project to the right until the proper length curve is intersected. From here drop to the cold spring factor and then across to the allowable stress and at the bottom read the number of bends. Chart is valid for all pipe schedules.

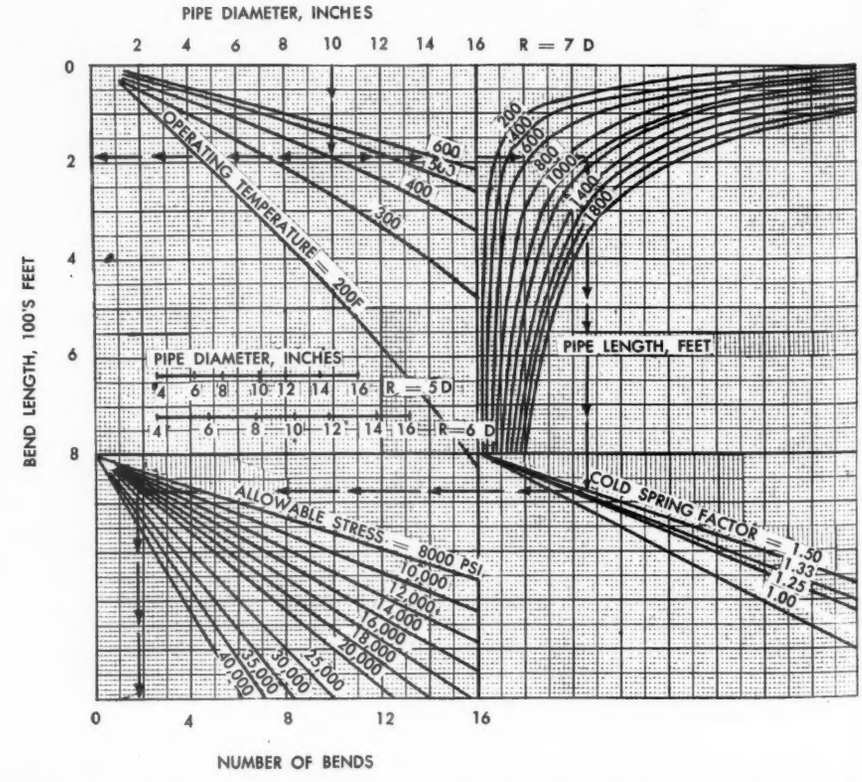
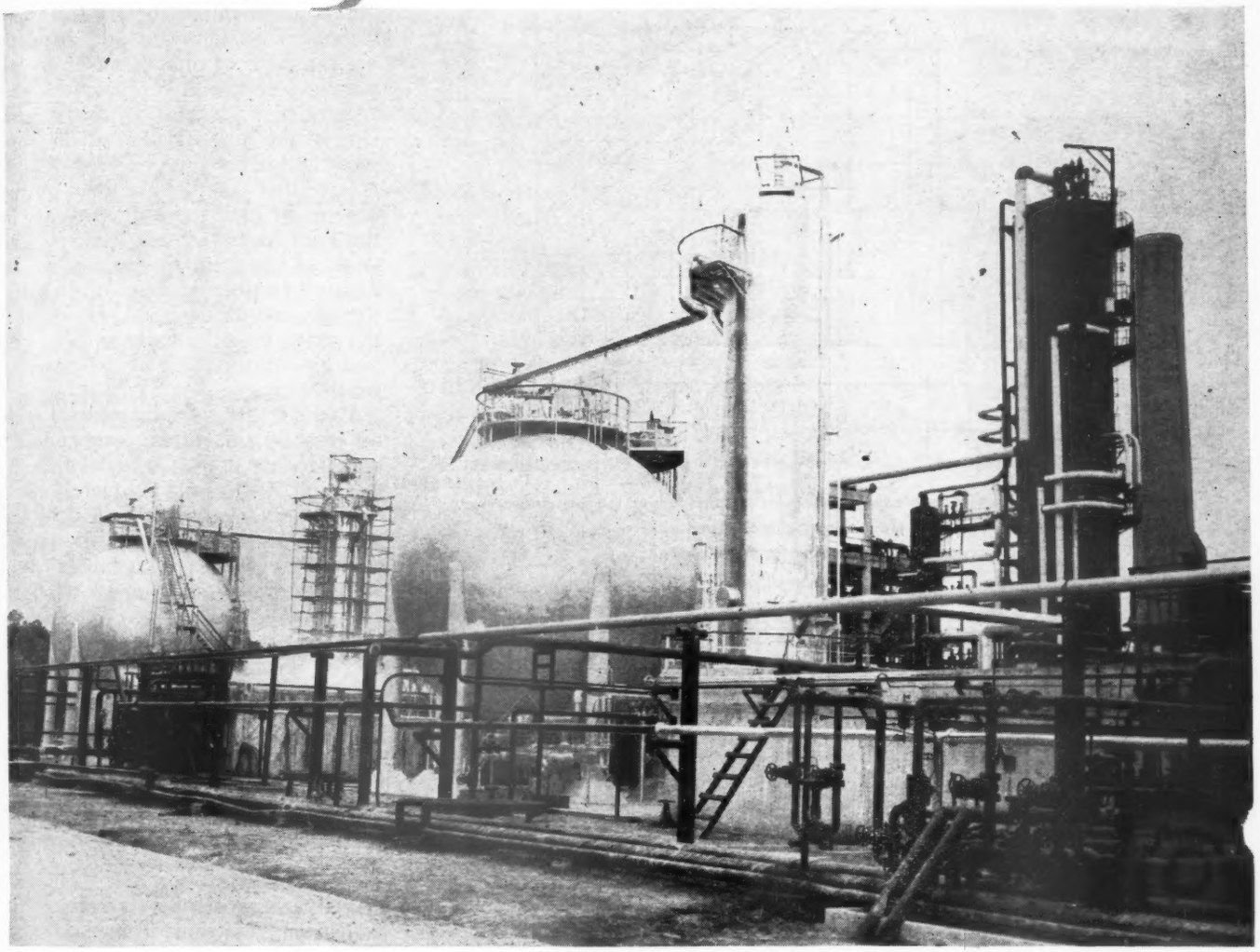


FIG. 5. Chart for finding the number of double offset U bends needed to absorb the expansion of a pipe line of given length operating at a known temperature. Use of this chart is the same as FIG. 4.

CITIES SERVICE } another leading refiner desalts with PETRECO



Cities Service has long been recognized for progressive leadership, dependable excellence of product and refining know-how. The first Petreco Desalter for Cities Service was installed in their East Chicago, Indiana, refinery. When their great new refinery at Lake Charles, Louisiana, was built, Petreco Desalters were installed as part of the regular refining flow system.

There is only one way to earn a *repeat* installation for a company such as Cities Service, and that is to produce results the first time. In this particular case the Petreco Electrosphere to the right in the picture above has delivered throughputs as high as 75,000 barrels per day for extended periods of time and was a considerable factor in the topping units continuous fifteen months run during which 30,000,000 barrels of oil were processed. Results such as these are the reasons why leading refiners continue to specify Petreco Desalting and Petreco Service.

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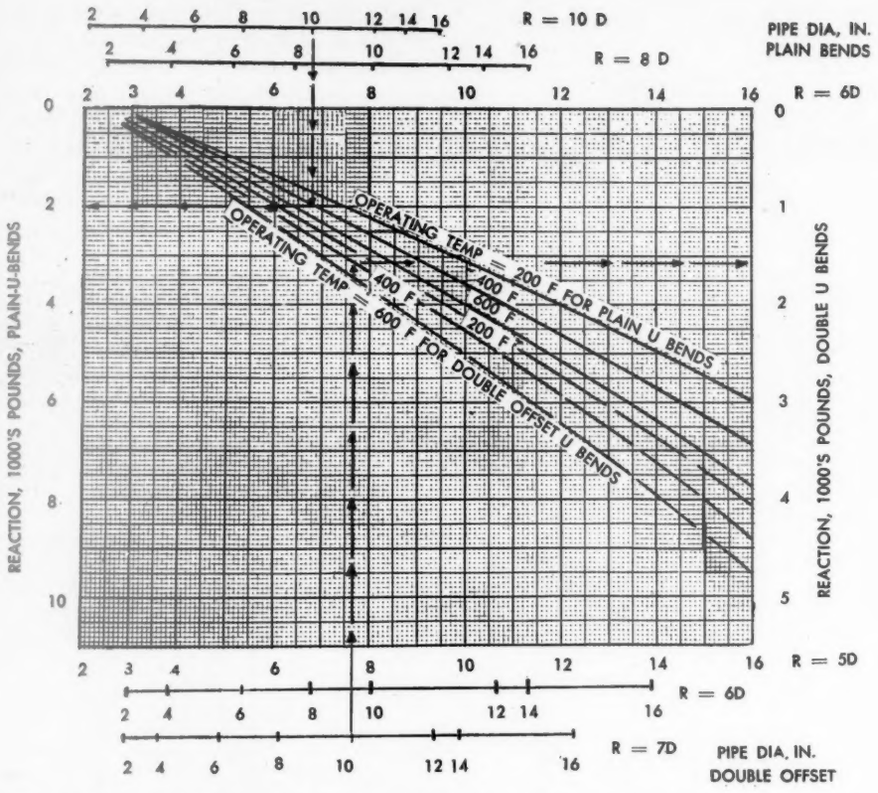


FIG. 6. Chart for finding anchor reactions in Schedule 40 pipe when the bending stress is 10,000 psi. For other stresses and pipe schedules, multiply chart force by the ratio of stresses and moments of inertia of the pipes.

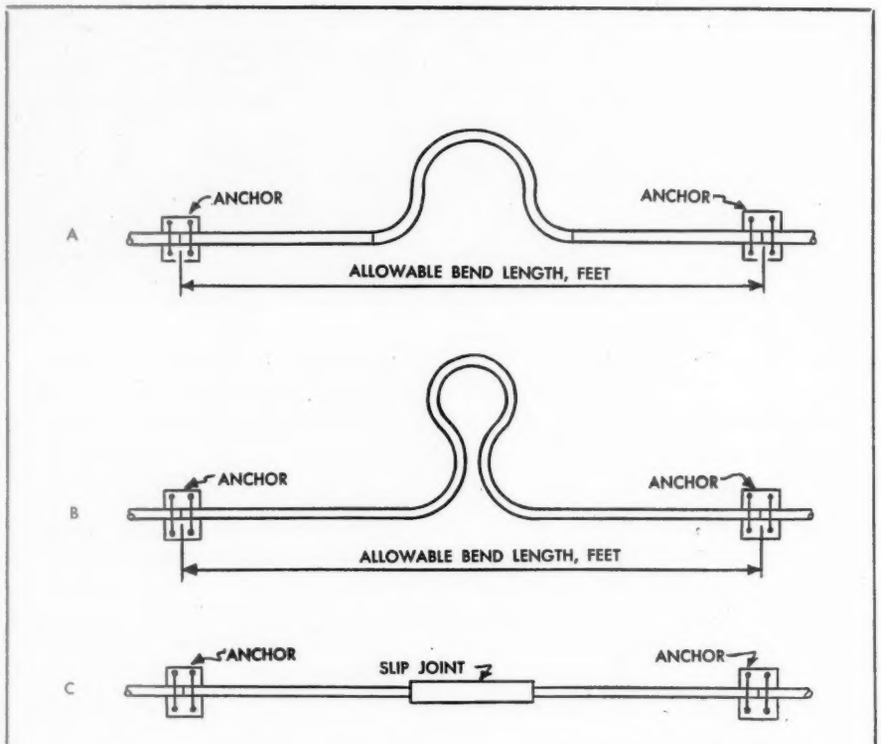


FIG. 7. (a) Anchor arrangement for refinery line with plain U bends for absorbing expansion. (b) Double offset U bends and their anchors. (c) Anchors for slip joints.

shown in Fig. 7c. Each joint must be anchored to the ground or supporting structure. Between joints the pipe must be adequately supported and free to move. Roller supports that guide and permit movement are usually best for this service.

Support friction varies somewhat but is usually assumed to be about 100 lb per support. At least 7 supports per 100 ft are required for a 10-in. pipe. Necessary anchor size and strength are functions of pipe diameter, steam pressure, slip joint construction, and type of supports used. During expansion of the pipe, friction at the supports and in the joint packing sets up a force that must be absorbed by the anchor. In addition, steam pressure in the joint tends to force it apart. The value of these forces can readily be computed and from the results a satisfactory anchor designed. Of course, the above remarks apply equally well to a pipe transmitting air, oil, gas, or gasoline.

Packing gland friction varies with different manufacturers, type of joint, and packing used. Gland friction in one type of slip joint frequently used for refinery work is about 2200 lbs per inch of pipe diameter. Assuming use of these joints in this line, anchor forces are found as follows:

10 in. Schedule 40 pipe:

Support friction $= \frac{1{,}000 \text{ ft}}{100}$ (7)
(100 lb/support) = 7,000 lb

Gland friction = 2200 lb/in.
(10 in. diam.) = 22,000 lb

Pressure force = 165 psig
78.9 sq in. pipe area) = 13,000

Total force to be
absorbed by anchor 42,000 lb

Comparison of these results with the anchor reactions for plain and double offset U bends shows that slip joints require larger anchors. When slip joints are used, however, only a minimum of pipe and insulation is needed because the pipe runs in a straight line between point of supply and use. The disadvantages of large anchors are thereby offset and pipe costs are usually about equal.

Conclusion

These charts have found much use in the design of refinery steam, oil, air, and gasoline piping. The results, when compared with exact mathematical analysis are quite accurate, and the time required to obtain them is far less. Although major recommendations of the Piping Code have been incorporated in this article, it is a good policy to refer to the Code whenever necessary during piping system design.

* * *

step by step for half a century an International Engineering Company grows . . . .

By ARCH L. FOSTER

EXCEPT for the discovery of crude petroleum and the learning of a few facts about its properties and uses, all the essential developments in the petroleum industry have taken place within the last fifty years. Except for a brief scanning of the fabrication needs of the embryo American fertilizer industry all the essential developments in the life and history of the international engineering firm of M. W. Kellogg Company have occurred during that same half-century.

That period of time has seen the petroleum refiner progress from the simplest of pot stills connnected by means of a "gooseneck", to the simplest of pipe coils immersed in water in a wooden-staved tank, to the exceedingly complex but highly efficient units of current refinery operation. In that 50-year-long geologic "instant" we have progressed from Rock Oil to rocket propulsion, from Drake's Folly to producing and distributing the most important commodity in world trade and world politics. No single physical thing on earth has done for the human race what petroleum has accomplished.

The trend all along has been toward the more complex technology, engineering, and chemistry in oil refining. Simple distillation gave way to fractionation, to thermal then to catalytic cracking, to chemical treating, isomerization, and alkylation, all directed toward "tailoring" of the hydrocarbon molecules to meet the specific needs of the world.

Kellogg's life has progressed parallel to that of the industry it serves. For this company, its history divides into two main phases, the Age of Fabrication and the Age of Process Development and Engineering. The first step occurred in 1900 when, before the formal organization of the present company, its founder established a consulting and pipe-fabricating service to the fertilizer industry. By 1901, when the company was officially formed, Kellogg was looking into power plants as a source of business. This progressed from production of pipe bends, joints and so forth to the fabricating of power piping such as penstocks for hydroelectric units. More or less simultaneously, a start was made in the field of industrial chimneys, an activity that is still in full swing and one that has broadened to include refractories and related materials.

In 1905 the original, small shop was bursting at the seams and a factory was leased to carry the overflow of business. As time passed, the company opened its own plant in Jersey City, including a large welding operation that was soon to build welded shell-type stills for the new Burton thermal cracking process, then suffering birth-pains in its revolutionizing of oil refining. Actually it was at this time that the Kellogg company began to emerge from its role of mechanical fabricators into an engineering corps.

Morris Kellogg and his aides looked far ahead and decided that fabrication alone would not keep them in the business of supplying the oil industry. Process know-how and interests in processes appeared necessary to guarantee organizational longevity. In 1919 a lone-eagle inventor, Richard "Dick" Fleming, offered his cracking process to Kellogg. Kellogg took it over, hired Fleming, developed the process as far as current technology made possible, and built a number of installations in different refineries. By 1923 the search for methods to crack oil to produce gasoline was as frenzied as any Klondike Gold Rush.

Two men, the Cross brothers, had developed a new type cracking unit. in which a small stream of oil passed continuously through heated pipe coils

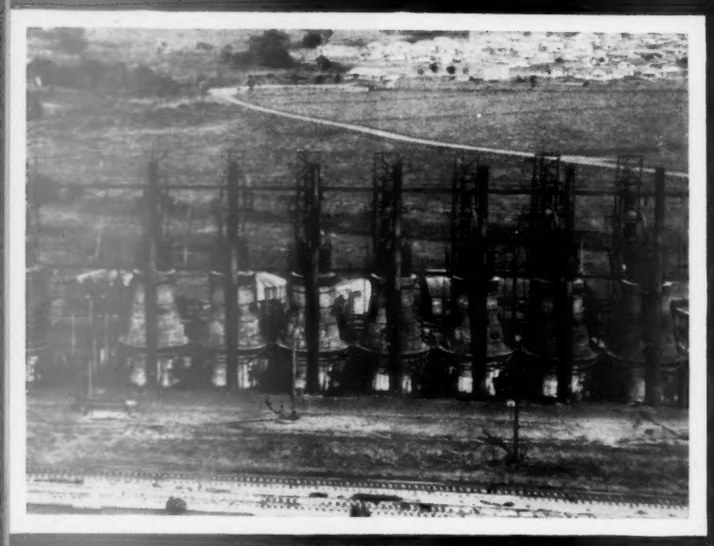
The first fluid catalytic cracker on page C-24 was a blueprint when World War II broke out. Much pilot plant data had already been gathered; but the actual design for the building of the unit was proceeding cautiously as is normal with any new process. The war changed this overnight. Kellogg rushed this unit to completion and began moving as fast as possible to design and erect eleven add'tional plants to produce desperately needed base stock for aviation gasoline. The insert shows early Fleming thermal units which present an interesting contrast to the first fluid cat built in 1942 —a 15,000 BPD unit. It would be dwarfed if placed alongside Kellogg's largest unit— 60,000 BPD—now being completed for Gulf.

KELLOGG
1901-1951
50th Anniversary

Commemorative Section of The Petroleum Engineer

Morris W. Kellogg, chairman of the Board of Directors of The M. W. Kellogg Company, founded the firm in 1901. As its first president he actively directed the company's business until 1944 when he became chairman.

Harold R. Austin was the second president to preside over Kellogg operations. He took office in 1941 and retired in 1950, steering the company through the final hectic days of World War II and through the initial postwar adjustment period. During the war the Kellogg engineering staff alone expanded from a few hundred to over 5,000 in manpower. Mr. Austin joined Kellogg in the earliest days of the company and until his retirement played a major part in the development of this engineering firm.



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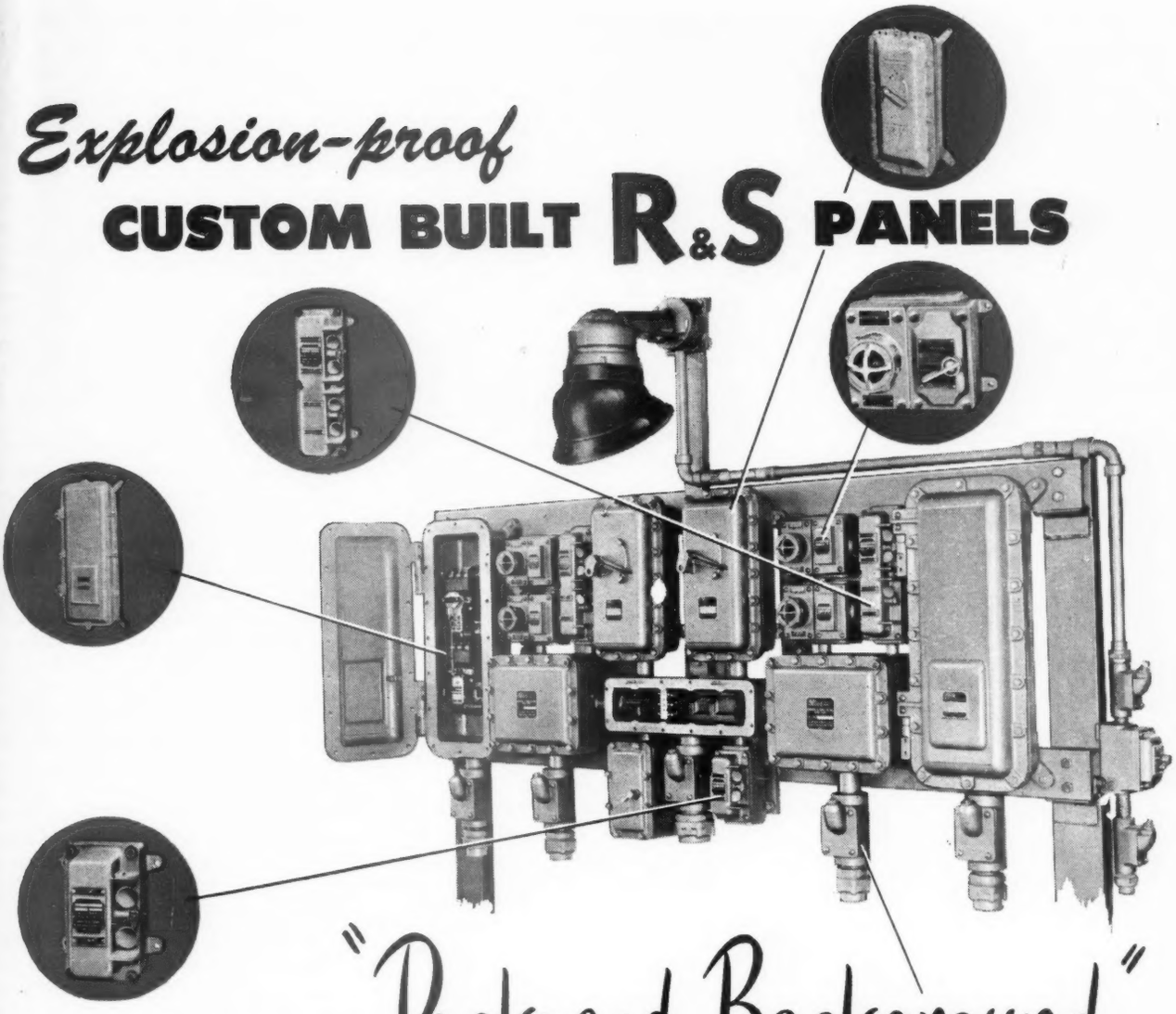

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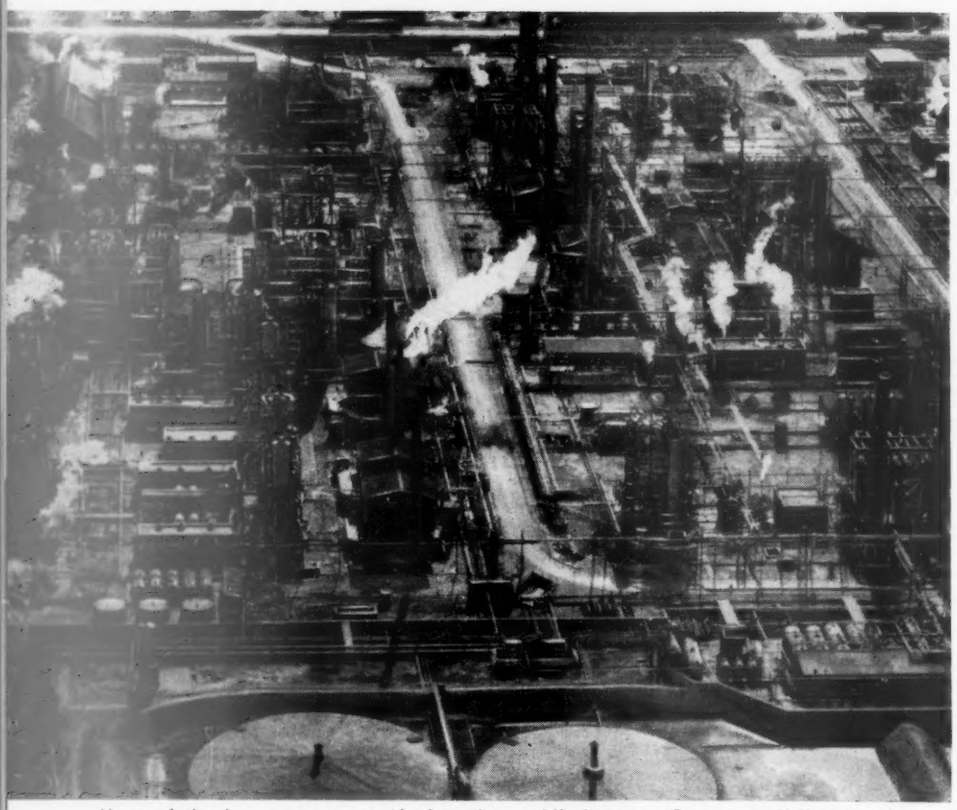
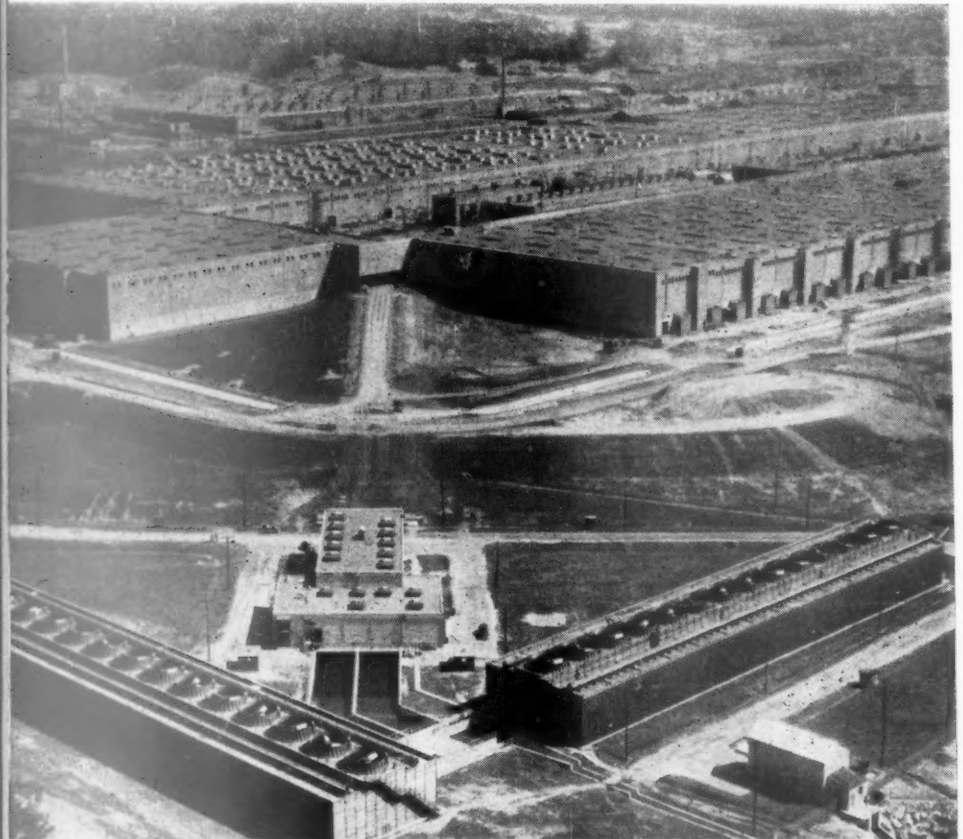


Many of the key processes at Abadan, the world's largest refinery, are Kellogg engineered and installed. These included atmospheric and vacuum distillation facilities, thermal cracking and reforming units, alkylation and others. Currently, however, the majority of Kellogg's work with AIOC is in the United Kingdom.

Oak Ridge, the world's most complicated process and largest chemical plant, represents the toughest single task ever assumed by Kellogg. To process design, engineer and construct this 500 million dollar plant, Kellogg organized the Kellex Corporation around a nucleus of Kellogg specialists. At the peak of its wartime activity Kellex comprised more than 2000 physicists, engineers, chemists, technicians, and others from the industry.



in a furnace and "soaked" for a period in a heavy steel drum at high temperature and pressure, and had formed the Gasoline Products Company to promote the process. To assist in its development, they reached an agreement with Kellogg on development and licensing, whereby more than 130 units were built in the United States and abroad, at costs totaling more than $125,000,000. The licensing-engineering agent held a part ownership in the enterprise and when Gasoline Products Company was sold to The Texas Company and Standard of Indiana, Kellogg retained an interest.

By this time the firm had grown to much larger size, and numbered its technical employees in the several hundreds. To meet the greatly increased needs for additional technical knowledge, a research laboratory featuring pilot plant units had been established at Jersey City alongside the fabricating shops, and work was going forward on numerous projects designed to improve the company's ability to develop processes and design units for commercial operation. That overall division now includes more than 500 scientists, engineers, and technical aides, a group that stands among the leaders in the most important researches in the industry at present, details of which will be given later in these articles.

Three major, and numerous minor ramifications of refining research now appeared, into all of which the company plunged in the role of an aid to and collaborator with oil company development outfits. Lubricating oil refining was just emerging from the Stone Age; solvent extraction, solvent dewaxing, and allied processes were under development; the Great Depression was on and all struggled to improve qualities and cut costs. Union Oil Company of California had carried out developments, so had Standard Oil Companies of Indiana and New Jersey. Combining interests and effort, these four companies worked out the JUIK agreement, whereby developments, knowledge, etc., were pooled. All collaborated in research, with Kellogg as the licensing-designing agent for these processes, which include propane dewaxing and deasphalting-deresining, phenol solvent extraction, etc.

Similarly, Phillips Petroleum Company, The Texas and Union Oil Companies and Standard Oil Companies of Indiana and New Jersey as well as Kellogg had carried on considerable research in the polymerization of olefinic light hydrocarbons to produce materials of gasoline boiling range. These companies formed an agree-

ment to collaborate and share in research development in this field.

Last and most far-reaching of these collaborative compacts is the Catalytic Refining Agreements (CRA), which included most of these companies, and which provided that developments they had made and were to make in the future were contributed to a common knowledge pool. The agreements included both catalytic cracking and hydroforming. Hydroforming was a strong effort to solve the problem of reforming low-grade naphthas into premium quality motor fuel, by the use of molecular hydrogen, heat and pressure and a catalyst, as will be shown in a later article. Catalytic cracking already had appeared on the commercial horizon in the Houdry Process, and was to be expanded into two other main processes as a lifesaver for Allied aviation fuels for World War II.

Mention must be made in passing of Kellogg's famous combination unit system of design, whereby atmospheric and vacuum distillation and thermal cracking and/or reforming were combined into one closed system in which the products of one step were passed continuously into the next step without intermediate storage, the entire operation being continuous from raw crude to finished products, omitting any chemical treating, rerunning (redistillation) which might be necessary in specific instances. A large number of these units were built, their adoption hastened and clinched by the economic demands of the Depression.

Kellogg collaborated closely with Standard of New Jersey and others in developing the Fluid catalytic cracking process, but the war broke out before this had really gone beyond the pilot plant stage. The intermediate "tailoring' was dispensed with, resulting in commercial units that almost literally "sprang full-grown from the forehead of Jove", from a small pilot plant to the big 15,000-20,000 bbl per day units turning out motor and aviation fuel direct from the fractionator. The first fluid cat unit was built at Baton Rouge, the type and pattern for all other war units.

The coal tar industry's total supply of aromatics, benzene, toluene, xylene, cumene, etc., was hopelessly inadequate so superfractionation units were built to extract aromatics in huge volume from hydroforming unit product streams, to meet the unprecedented demands of the war for explosives and avgas.

Hydrocarbon alkylation, using sulfuric acid as the catalyst, had been well developed before the war broke and became a controlling factor in the production of aviation super-fuel. A large number of these units were built rapidly under war pressure, to augment the output of prewar sulfuric units and the HF units, which were built simultaneously.

Uranium-235

Probably the greatest, and most baffling single job ever undertaken by Kellogg was the development and building of the gaseous diffusion unit, K-25, at Oak Ridge, by means of which the potentially highly explosive U-235 was concentrated in a form in which it could be employed in the atomic bomb. For this purpose a subsidiary company, Kellex Corporation, was organized. Kellex grew into a 2,000-man unit and postwar was retained in "reduced" status for continued research in many lines. Last year, in a move to concentrate available engineering effort, the subsidiary was sold.

Outstanding in Kellogg's history is the development of the Synthol Process for the synthesis of liquid petroleum products and petrochemicals from hydrocarbon gases. Kellogg has carried on development work on this process for close to twenty years; only recently a unit utilizing this synthesis process has been sold to a South African company, which will utilize low-cost coal as the source of synthesis gas.

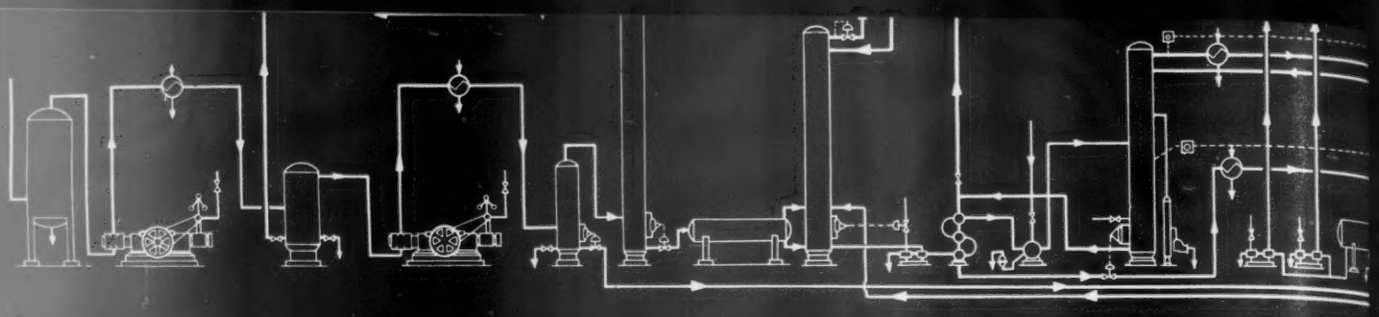
Bare mention can be made of the non-petroleum projects being carried on by Kellogg. Solexol is a process whereby animal fish and vegetable oils are purified via solvent propane to produce far superior oils for innumerable industrial and consumer uses. A process for cracking naphthas to make ethylene as an intermediate for plastics and other petrochemical products has been designed and engineered for an English chemical company, Imperial Chemical Industries, Ltd. Jet engines and rocket power plants are being studied intensively and developed under stringent secrecy limitations, for governmental departments. This work includes some of the most interesting of all developments in the field to date. The commercial development of Kel-F, a trifluorochloroethylene plastic with remarkable properties and innumerable commercial-industrial applications, has been accomplished to a point where Kellogg is boosting production rapidly to meet a continually mounting demand.

Someone has said that an industrial or commercial company is made of a common idea and the minds and efforts of a number of men. To illustrate this apparently axiomatic fact, shown here are likenesses and brief backgrounds of four of the small group of men responsible for the formation of the Kellogg organization and for its growth during the first 49 years.

Commemorative Section of The Petroleum Engineer

Frank F. Johnson Sr., retired vice president, was another of Kellogg's earliest associates and part of the team which created the business. He was instrumental in arranging many of the cooperative development activities with major oil companies which helped to establish Kellogg's process position in industry.

Louis H. Horvison, former Kellogg executive vice president, who retired in 1949, was largely responsible for interesting Mr. Kellogg in advanced petroleum processing. He personally sold many of the earliest Cross units and in later years was responsible for the top supervision of some of Kellogg's largest projects.



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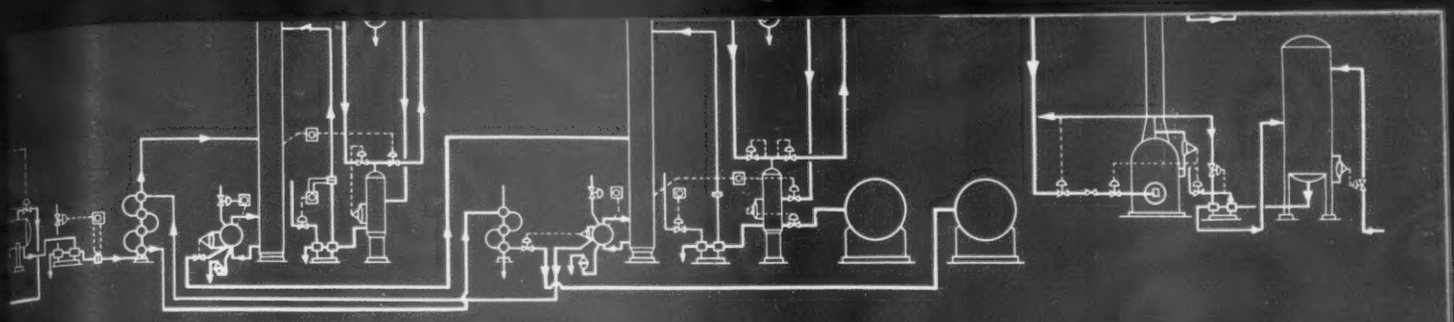

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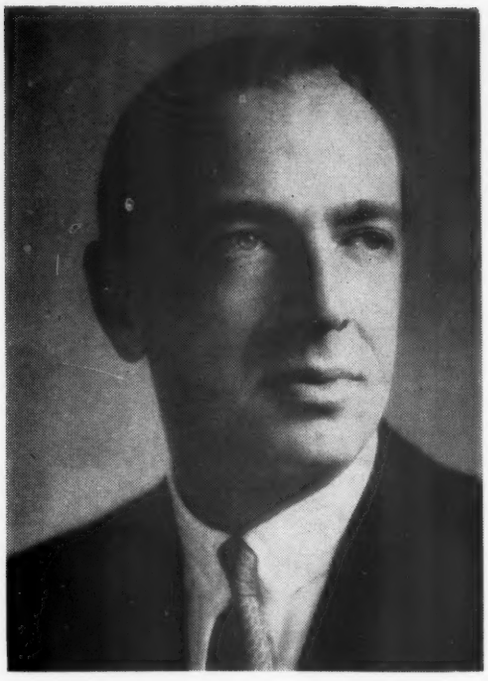


WARREN L. SMITH
President of
the M. W. Kellogg
Company

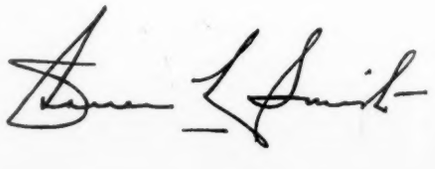
IT is a signal honor to have our company's Fiftieth Anniversary commemorated by the editors of *The Petroleum Engineer*. I feel, however, that the editors in singling out our company, are in truth telling a much greater story than that of any one corporation in our industry. In fact, they are symbolically telling the story of the tens of thousands of individual engineers and technicians throughout the industry who devote their lives to petroleum refining progress.

Naturally, hundreds of these engineers are Kellogg men, but many more thousands are refiners' men. Still more thousands serve the industry effectively from the suppliers' laboratories and drawing boards. And many are with our able competition.

Truly, petroleum progress is the result of their combined efforts to make better products at lower costs. Of course, we are proud of our past contributions to this progress, but all our present thinking and efforts are directed to making our future as fruitful.

It is a provocative future, whether it holds an expanding employment of the technological "status quo" . . . the widespread use of coal and natural gas as the raw materials for synthesizing liquid hydrocarbon fuels . . . or even some entirely new refining practice or entirely new source of energy. Regardless of the specific direction of future technology, there is bound to be continuing progress . . . and that in itself is a challenge. But it is a challenge that can only be met successfully through forward-looking development work in both technological and human relations fields.

To the many companies in our own and allied industries that are also celebrating their Fiftieth Anniversaries this year, our good wishes . . . with the hope that they will join with us in meeting this "challenge **at fifty**" to the benefit not only of their own companies but, more importantly, to the benefit of all mankind.



Here is the current management team entrusted with employing the talents of the Kellogg organization to best advantage. It's a team of engineers . . . some who have grown with Kellogg, some with specific experience who have been brought into the family within recent years to point up the new and expanded phases of Kellogg operations. (Names on opposite page.)

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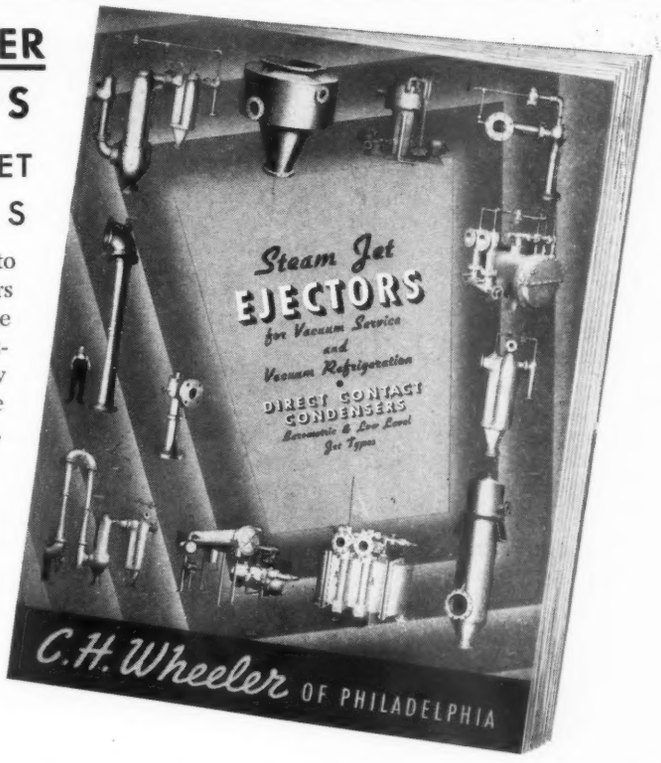

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The formula employed by the customer and a tabulation of his figures has been reproduced for your appraisal. This, together with Catalog 145, will augment your knowledge of cooling tower operation. A request on your company letterhead will bring them by return mail.

Be sure to call a C. H. Wheeler representative early in your cooling tower plans. He shows you where to check for features of quality.

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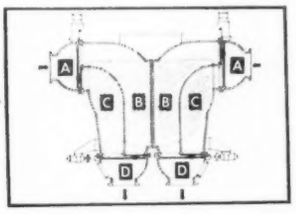
By an arrangement of electrically or hydraulically controlled sluice gates the flow of water through the condenser tubes is reversed. Refuse is flushed down the discharge in minutes, thus saving hours of downtime for hand cleaning. Here is how it works:



Both halves work the same but independently of each other. Left Side: Water enters divided water box at valve chamber A, with upper port open. It flows through pass B to end of condenser, back through pass C and out through left port of D.

Right Side: Flow is reversed: Valves at inlet A and discharge D are changed to permit water to flow through C and back through B in the opposite direction, then out through lower port of D.

C. H. WHEELER MANUFACTURING CO., 1832 SEDGLEY AVE., PHILADELPHIA 32, PA.

KELLOGG
1901-1951
50th Anniversary
Commemorative Section of The Petroleum Engineer

LUTHER R. HILL
in charge of
Process Engineering
the M. W. Kellogg Company

THE PROCESS DESIGN SET-UP AT KELLOGG

IN the more than 20 years that I have been with Kellogg, the technology of refining has undergone a revolution—so also in a lesser degree has the process design set-up at Kellogg. Originally, our group consisted of a mere handful of chemical engineers. Today, it is a full department, with breadth and depth, organized into five major specializing sections.

Supporting our original process engineering group there was the beginning of a laboratory with one or two pilot plants and a comparatively small cadre of mechanical design engineers. Today, the process department is backed by a fully-staffed chemical research laboratory, with a special group working on nothing but catalysts; pilot plant laboratory that includes some 20 pilot plants (some of them cost $1,000,000 and more before they turned out their first products); chemical engineering development group that specializes in improving the unit chemical operation, and probably most important, an experienced economics section whose function it is to evaluate the economics of process engineers' plans and proposals. And to translate the work of these groups, there is a mammoth design engineering department with veritable floors full of specialists.

All told, this force totals in the hundreds counting only the experienced engineers and laboratory technicians. Reviewed on the following pages are a few of the more important or new processes of modern refining, with indications of Kellogg's recent refinements or explanations of Kellogg's approach to design.

Here by the bend in the river is one of the nation's largest refineries . . . and it was the largest ever given to one engineer-contractor to completely process, engineer, and erect. With its three Fluid crackers, alkylation-isomerization plant, thermal reforming and cracking, topping, deasphalting and other facilities, this Cities Service refinery at Lake Charles marked a high point in integrated petroleum processing design.

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DISTILLATION

KELLOGG built its first atmospheric distillation unit more than 25 years ago, but today is still actively engaged in research to improve this basic refining process. Although operating data have been accumulated from Kellogg-built units, which process a total of more than a million barrels of crude daily, the company is continually supplementing this with visual data from a unique, Lucite bubble tower operated in its development laboratories. As a result, many of tomorrow's fractionating towers may be physically smaller with no decrease in throughput.

In addition to this visual study of the dynamics of fluids, Kellogg's laboratories also include other fractionating equipment for studying yields and other essential processing data.

Typical of a modern topping unit is the one for Skelly illustrated at right. Close fractionation provides high flexibility in the end use of various cuts.

Eight streams may be taken off including reduced crude, virgin gas oil, diesel oil, kerosine, heavy gasoline, light straight-run, and light ends. The eighth stream is a close-cut naphtha that comes off as bottoms from the re-run tower and is used in the production of special solvents.

FEED PREPARATION

WITH the advent of catalytic cracking, the preparation of extra-clean feed for this process became a matter of major concern to the refining industry. Several familiar processes may be employed for this purpose, their use being determined largely by economics of the individual refiner's processing sequence. Most common feed preparation steps are delayed coking, vacuum flashing, and propane decarbonizing. Visbreaking may also be used, but as a process it is more generally associated with combination thermal refining.

Currently, 7 out of every 10 bbl of oil put through delayed coking units go through Kellogg-designed and built equipment. Although this type of unit may be operated as a visbreaker, it is most frequently used to produce extra clean feed for catalytic cracking and high quality coke as a residual product.

The concept of delayed coking originated with Standard Oil Company of Indiana in the late twenties and was developed into commercial production by that company, which built the first commercial unit in 1931. Since that time Kellogg has continued the development and refinement of the process at the Jersey City labs. Pilot plant data are continually being provided and new processes for coking are currently under study.

The value of vacuum flashing in producing clean feed for catalytic cracking without thermally cracking portions of the reduced crude is well known to the industry. A properly designed vacuum unit, although reducing atmospheric bottoms to asphalt, does not reduce these bottoms to as low a percentage as is obtainable in propane decarbonizing. The bottoms product can be blended into fuel oil or sold directly as asphalt, however. Virgin characteristics of overhead products are retained by keeping cracking action to a minimum.

Capacities of Kellogg-designed units have ranged from 500 to 55,000 bbl per day—the latter, about ready to go on stream, is believed to be the largest in the world. It is being erected for California Standard at its Richmond refinery.

Propane decarbonizing—a process stemming from Kellogg's close association with the JUIK lube processes—has since 1944 been a factor in the preparation of feed stock for catalytic cracking. A relatively recent installation of this process has it operating in combination with a crude distillation unit in order to reduce initial costs and lower operating expense.

Top—One of Kellogg's most recent crude units to go on stream in the United States is this 36,500 bbl per day modern plant for Skelly Oil in El Dorado, Kansas. Right—An interesting example of combination refining was designed and erected by Kellogg for British American Oil at Montreal. Here, topping is combined with propane decarbonizing.

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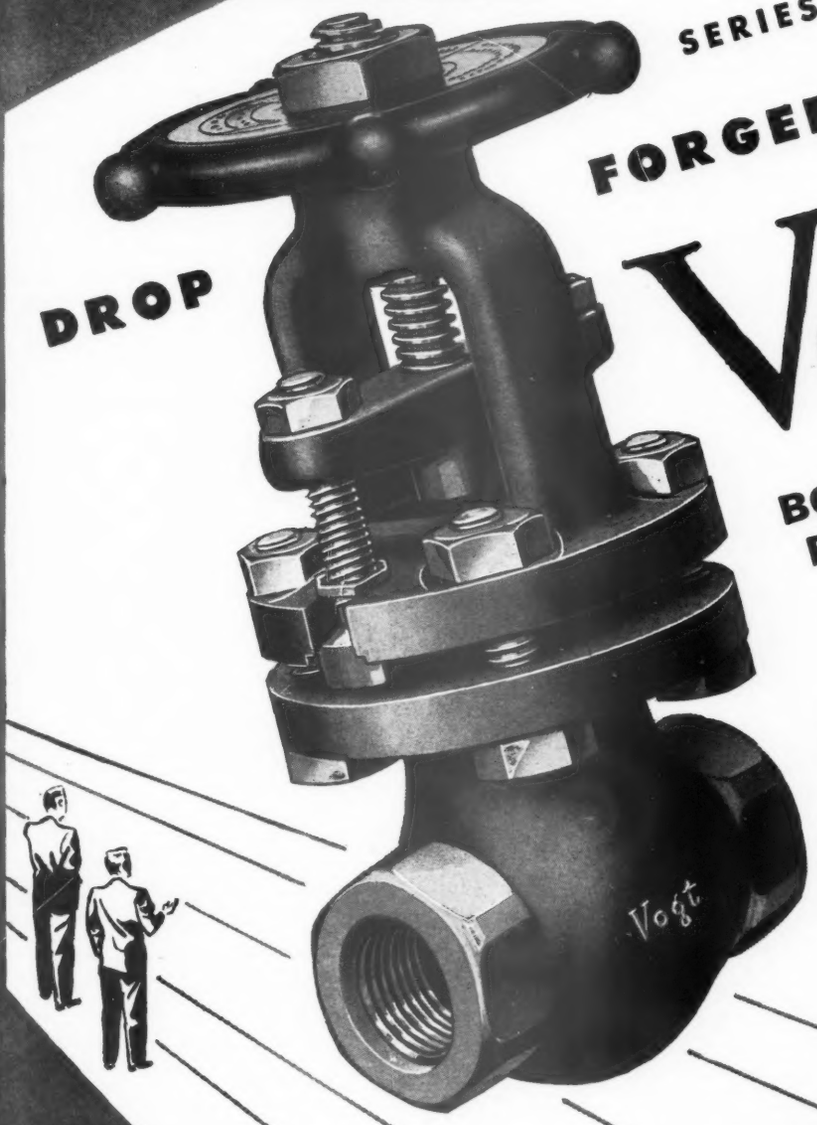

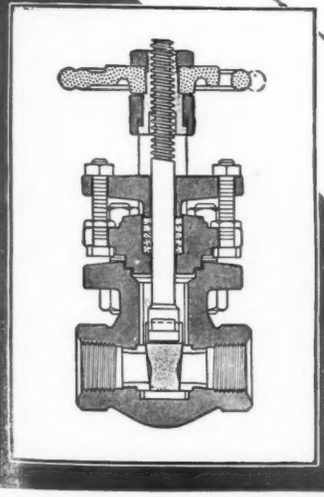

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COMBINATION THERMAL UNITS

TODAY, combination thermal refining no longer excites the domestic refiner as it did during the mid-thirties. But it still has a sound market in countries abroad where the need for high octane catalytically cracked gasoline is far overshadowed by the more basic need for an increased refining capacity.

It was in the early thirties that Kellogg first introduced the balanced combination thermal unit. Refiners found this method of reducing both investment and operating costs extremely attractive in many situations. Combination units provide distinct dollar savings by eliminating duplication in control rooms, intermediate tankage, piping, heat exchangers, personnel, and other operating charges. In the past 20 years Kellogg has designed, engineered, and constructed more than 30 combination units. These range in application from thermal units through catalytic cracking and into the lubricating field with such combinations as topping and delayed coking, catalytic cracking, and polymerization and complete facilities for producing lubes in one continuous propane stream.

In combination thermal processing, one of the most recent project completions concerns the new refinery for the Refinaria Nacional de Petroleo at Bahia, Brazil. The processing facilities include: Crude oil distillation, naphtha reforming, gas oil cracking, reduced crude visbreaking, gas recovery, gasoline stabilization, and caustic washing of gasoline and kerosine.

The unit is designed for two operations, the production of the maximum amount of gasoline, and for producing specified quantities of kerosine and diesel oil. In the latter operation, the naphtha reforming charge is undercut to 350 F end point.

FLUID HYDROFORMING

THIS new process has several advantages over the fixed-bed hydroformers built during World War II to provide vast quantities of toluene and avgas. In these earlier hydroformers, reaction beds had to be alternately taken out of product production while the catalyst was regenerated. The new Fluid catalyst system continuously withdraws catalyst from the reaction zone and regenerates it simply and cheaply. Daily operating costs will be approximately 30 per cent lower than those of a fixed bed with the same capacity. Furthermore, Kellogg estimates that this new type of unit will cost one-third less to build for equivalent capacities.

Kellogg pilot plant data indicate that yields will be on the order of 3 to 5 per cent higher than that of the fixed bed. This is due, by and large, to the uniform nature of the reaction, a result of the uniform temperature throughout the Fluid bed. Reactor pressures are also moderate in comparison with other catalytic reforming processes. As a result, the process shows better liquid recovery. The final gasoline product also contains less butane. This means that the refiner can advantageously blend extraneous butanes from other refinery sources into the hydroformed gasoline in bringing it up to the permissible 10-lb Reid vapor pressure.

Process Description

In the operation, fresh feed is charged to an absorber from which it passes through exchange to the main heater where its temperature is raised to approximately 950 F. From there the feed is charged to the base of the reactor in which the Fluid bed is maintained. The vaporized naphtha passes up through the bed (where the hydrocarbon molecules are reformed from straight-chain paraffins to ring-type aromatics) and into the separation section above the bed level. After passing through cyclones at the top of the reactor to remove entrained catalyst, the reformed hydrocarbon vapors are transferred to the main fractionating tower and introduced at a point just above the slurry settler.

Taken off as bottoms from the tower is a certain small amount of relatively high boiling point polymer made during the processing. This is charged to a flash drum and recovered separately for petrochemical processing.

Fluid Hydroforming

As this issue was going to press, announcement was made by Kellogg that it had contracted to engineer and erect the world's first Fluid hydroformer. This followed closely on the heels of an announcement by Standard Oil Development Company that the process had reached a stage where it appeared economically feasible as a method of catalytically upgrading naphthas.

The unit now on order—its capacity is rated at 2000 bbl per day—is for Pan-Am Southern Corporation and will soon be under construction at this refiner's Destrehan (Louisiana) refinery, which is undergoing a modernization program.

Principal product leaves the fractionator overhead and goes to a high pressure receiver that separates the hydrogen-rich gases from the gasoline. The gasoline is stabilized and sent to storage. The gases are recycled to the base of the reactor after passing through heat exhangers and heater to maintain the required hydrogen-rich condition in the reaction zone.

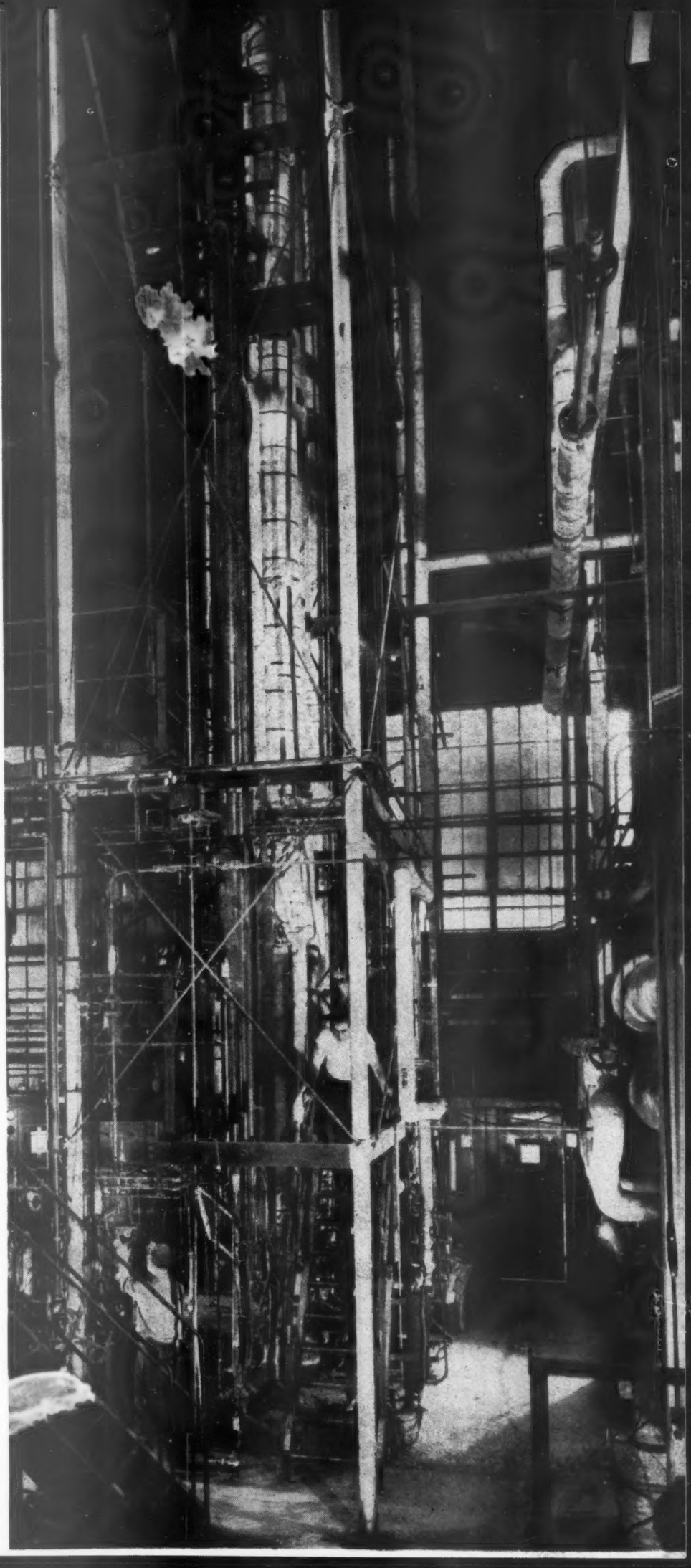
The movement of the Fluid catalyst is similar to that in Fluid catalytic cracking. From the reactor it passes through a stripper to remove and save hydrocarbon product and is then charged to the regenerator where the coke is burned off before it is returned to the reactor. Heat generated in regeneration is used to produce process steam through the use of an integrally contained boiler.

Typical Yields

Varying operating conditions produce different yields and octane ratings. Under severe operation, the octane rating of the product is 95 CFR-R (Clear).

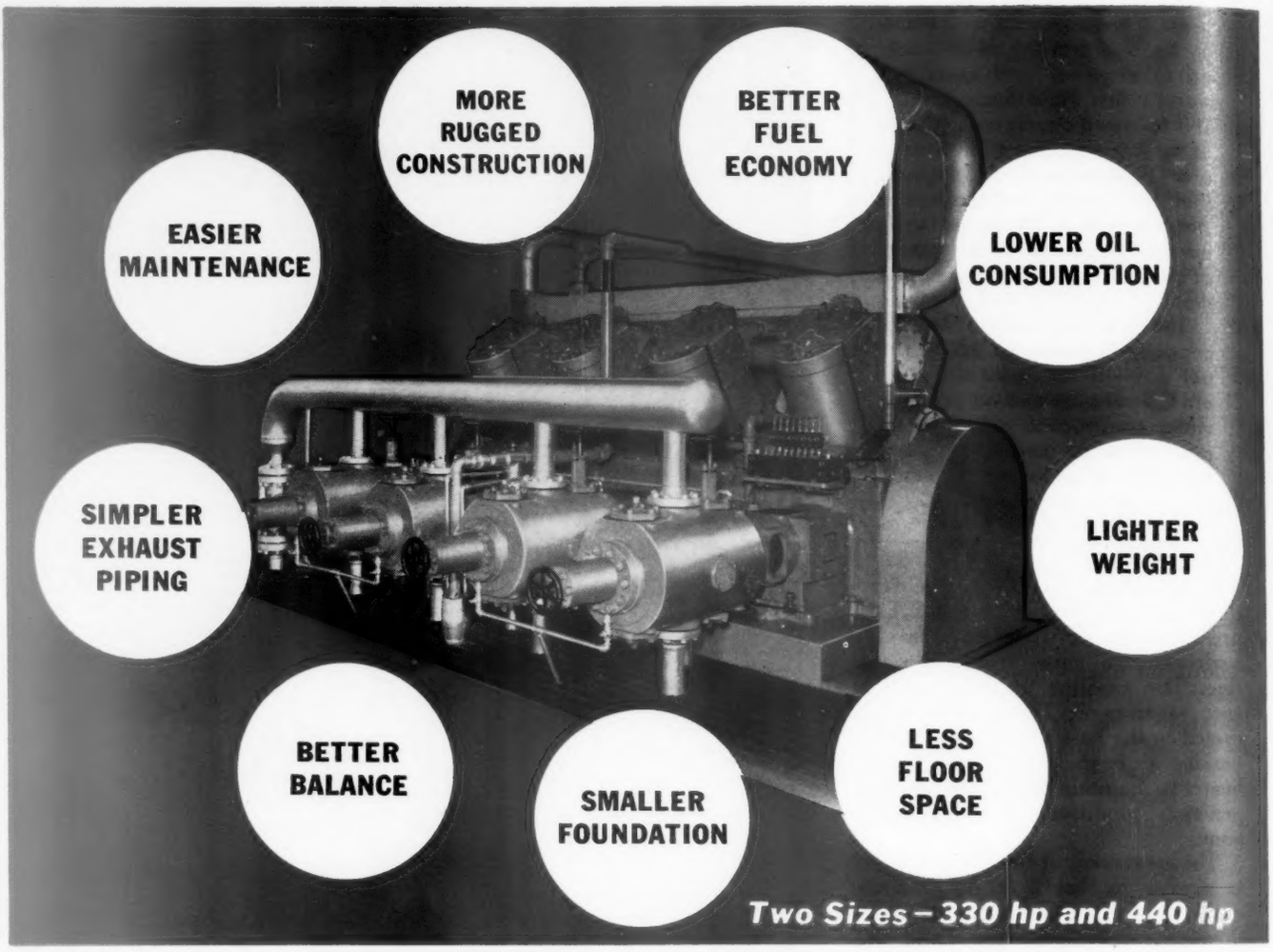
Operating for the prime purpose of producing avgas base stocks, the aviation octane ratings reach 98, F-3, and over 175, F-4, with the addition of 4.6 cc. of TEL per gallon.

In actual refinery practice, through blending of extraneous butanes, the total volume of finished gasoline approximates 100 per cent of the liquid charge volume.



This is the pilot plant in Kellogg laboratories from which came much of the data used in designing the first Fluid hydroformer.

THE NEW, HEAVY-DUTY SVG IS BETTER ALL AROUND



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The *new SVG* gas-engine-driven compressor is essentially the well-known XVG 4-cycle V-angle compressor . . . improved and modernized by a complete redesign from the ground up and from the inside out.

For twenty years the famous XVG compressor has maintained its position as a standard of comparison. Time after time new developments were incorporated into the XVG construction, but there are limits to improving an existing model. There comes a time when a departure from even such a successful model is necessary.

The *new SVG* retains all of those features that have been so successful in the XVG, and takes advantage of new materials, modern rotative speeds, up-to-date manufacturing methods, and "know-how" based upon many years of experience in building both compressors and engines. The *new SVG* is the modern-design gas-engine-driven compressor with an outstanding background . . . a better compressor, all around.

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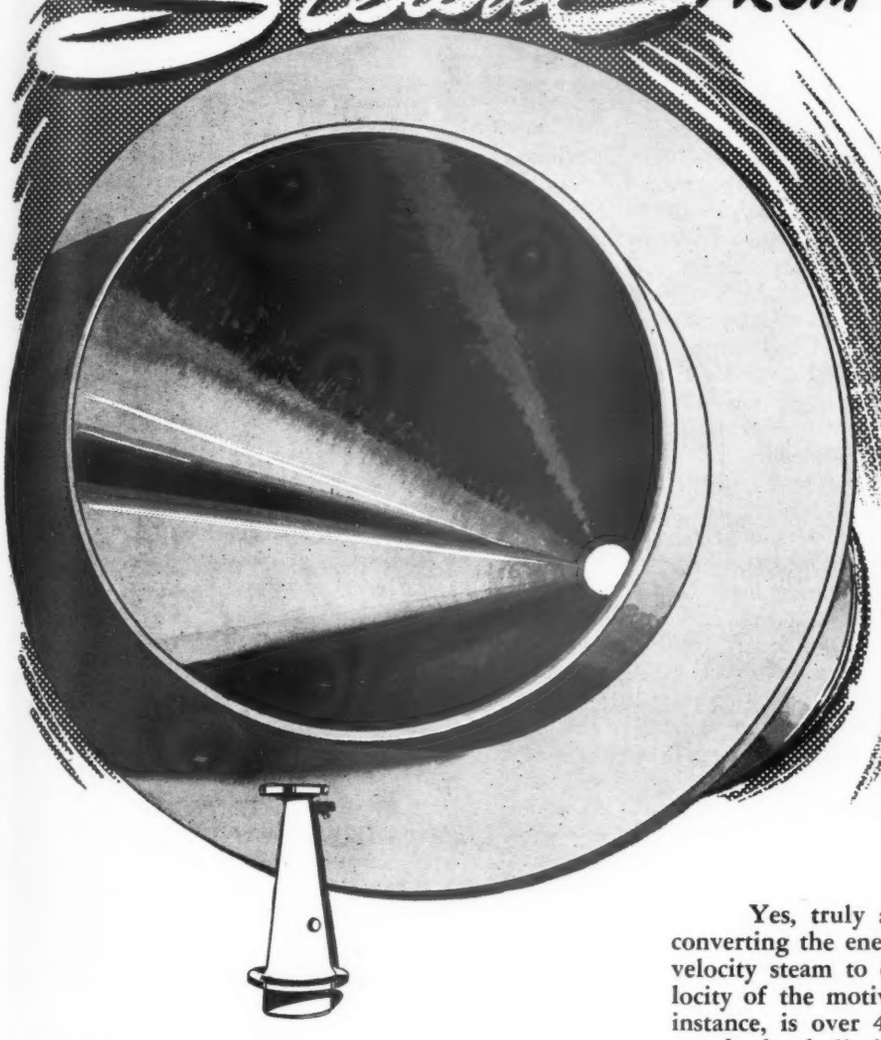
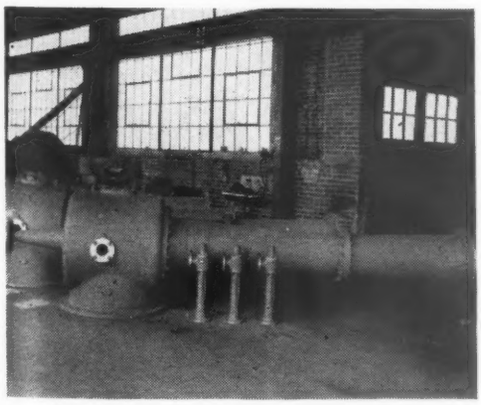
Steam FROM THIS NOZZLE MOVES 50,000 C.F.M. VAPOR IN A CR EVACTOR!



Side view of nozzle shown in end view above. This nozzle is made from a stainless steel casting with all internal surfaces fully machined and polished. Extremely close tolerances are a CR feature on finished dimensions.



Booster Evactors of the above-mentioned capacity awaiting shipment to a CR customer.

Yes, truly amazing results have been obtained by converting the energy of steam to velocity and using high velocity steam to entrain vapor at high vacuum. The velocity of the motivating steam in this CR equipment, for instance, is over 4,000 feet per second—the approximate speed of a bullet!

In one such CR unit—with a 30″ diameter suction connection—the capacity handled at 29.7″ vacuum (referred to a 30″ barometer) is 1600 pounds per hour of water vapor from a vacuum crystalizer. In terms of volume this is over 3,000,000 cubic feet per hour or 50,000 cubic feet per minute.

Each complete CR unit consists of a 30″ Booster Evactor described above, a 52″ barometric condenser and a small two-stage Evactor for air leakage.

These particular units are used to chill rayon spin bath liquor for crystallizing out sodium sulfate. After the process the liquor is fortified with fresh acid and used again.

For those interested in refrigerating capacity at 45° F. each of these CR units is equivalent to 140 tons of ice per day. Similar units are offered in many smaller sizes and for a great variety of other industrial vacuum requirements.

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CHILL VACTORS STEAM JET EVACTORS CONDENSING EQUIPMENT

CROLL-REYNOLDS

GASEOUS PRODUCTS

ALTHOUGH originally used almost exclusively in the production of aviation gasoline, alkylation is currently enjoying a resurgence not only as an avgas process but also to help meet the demand for octane upgrading of automotive fuel. Over the years, Kellogg has been closely associated with sulfuric acid alkylation and has contributed several design features. Most recent of these is the new cascade reactor vessel, in which the ratio in the actual reaction sections of the vessel averages better than 9:1, although the overall feed of isobutane and olefin is kept at a relatively low 4:1 ratio. This is accomplished by splitting the total olefin feed between three reaction sections and introducing *all isobutane* and H_2SO_4 into the *first* of the three sections. As the process proceeds, the resulting mixture cascades from section to section. As the olefin and isobutane react in approximately a 1:1.1 ratio and as only one-third of the total olefin charge comes in contact with the isobutane at any given time, a localized high concentration of isobutane is realized.

For the refiner who has no use for spent acid one of the problems is the consumption of sulfuric acid and production of by-product spent acid in alkylation. Along these lines, Kellogg is currently developing a new reconstitution process, which, at extremely low investment cost, can be incorporated into the alkylation plant.

Catalytic Polymerization

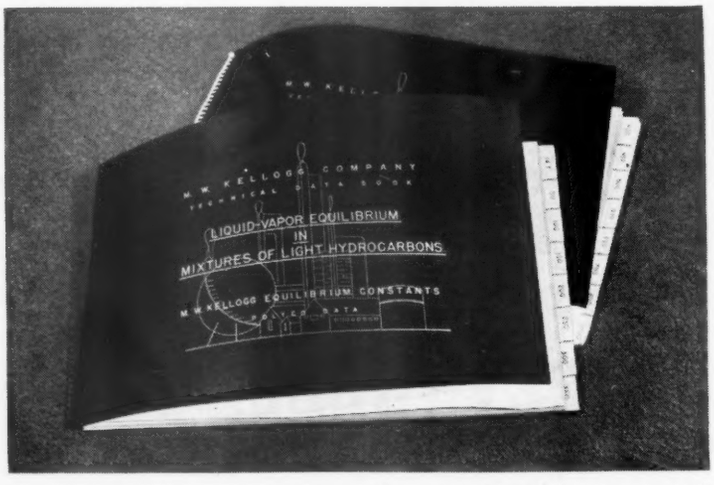
CATALYTIC polymerization combines gaseous olefins to form high octane polymer gasoline by use of a special catalyst and high pressure.

Elimination of the cracking action present in the thermal method allows closer control of product quality. Lower initial costs of installation and lower operating costs are other important factors in favor of cat poly.

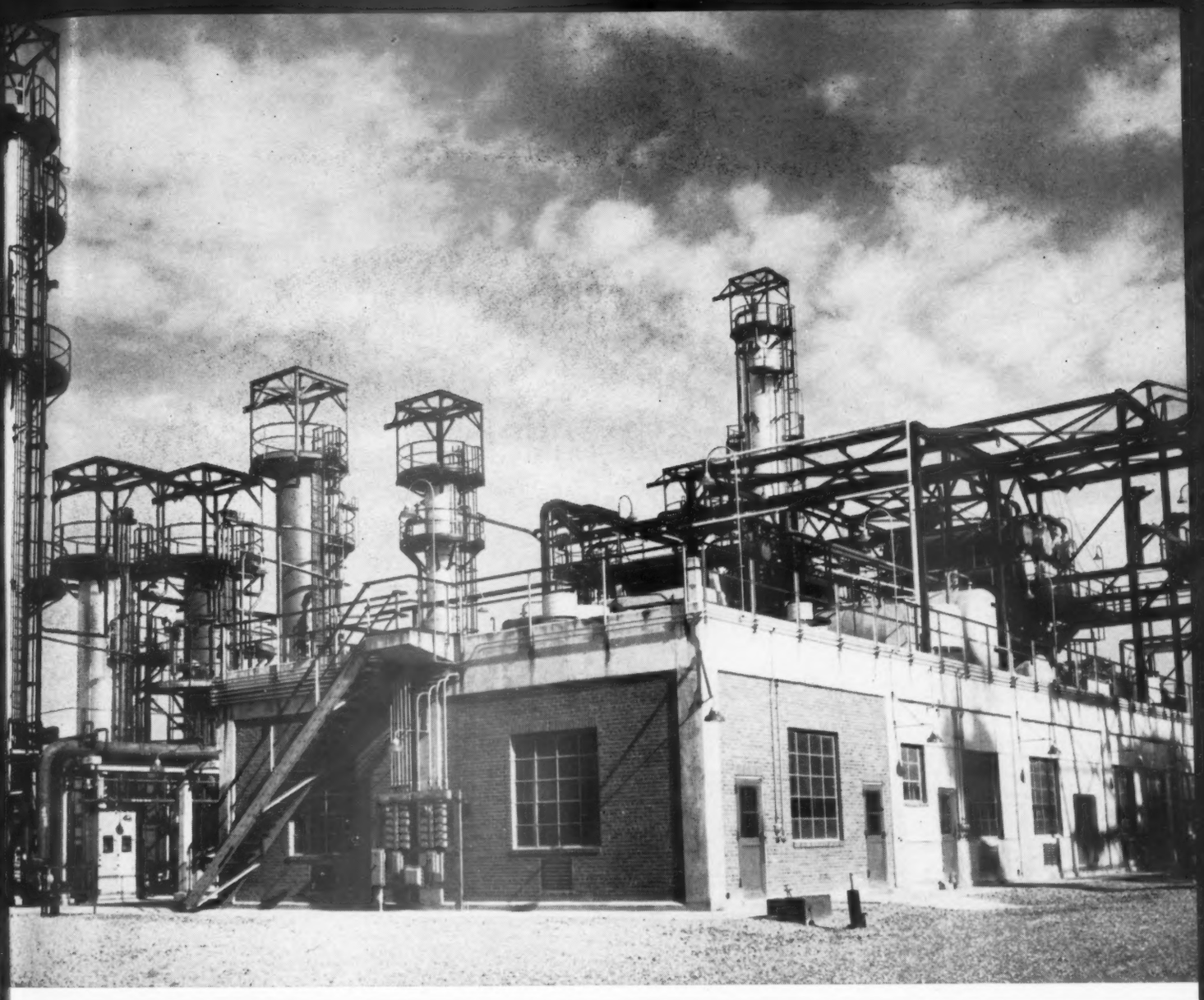
In addition to producing polymer gasoline, this process can, through the selection of feed under carefully controlled operating conditions, make a product that is substantially iso-octene. This polymer, generally termed codimer, may then be hydrogenated to form a material that is essentially iso-octane. Cat poly may also be used to produce cumene by charging a special mixture of benzene and propylene. Wartime uses of cumene have established that extremely small quantities of this material produce a marked improvement in the octane of motor gasoline.

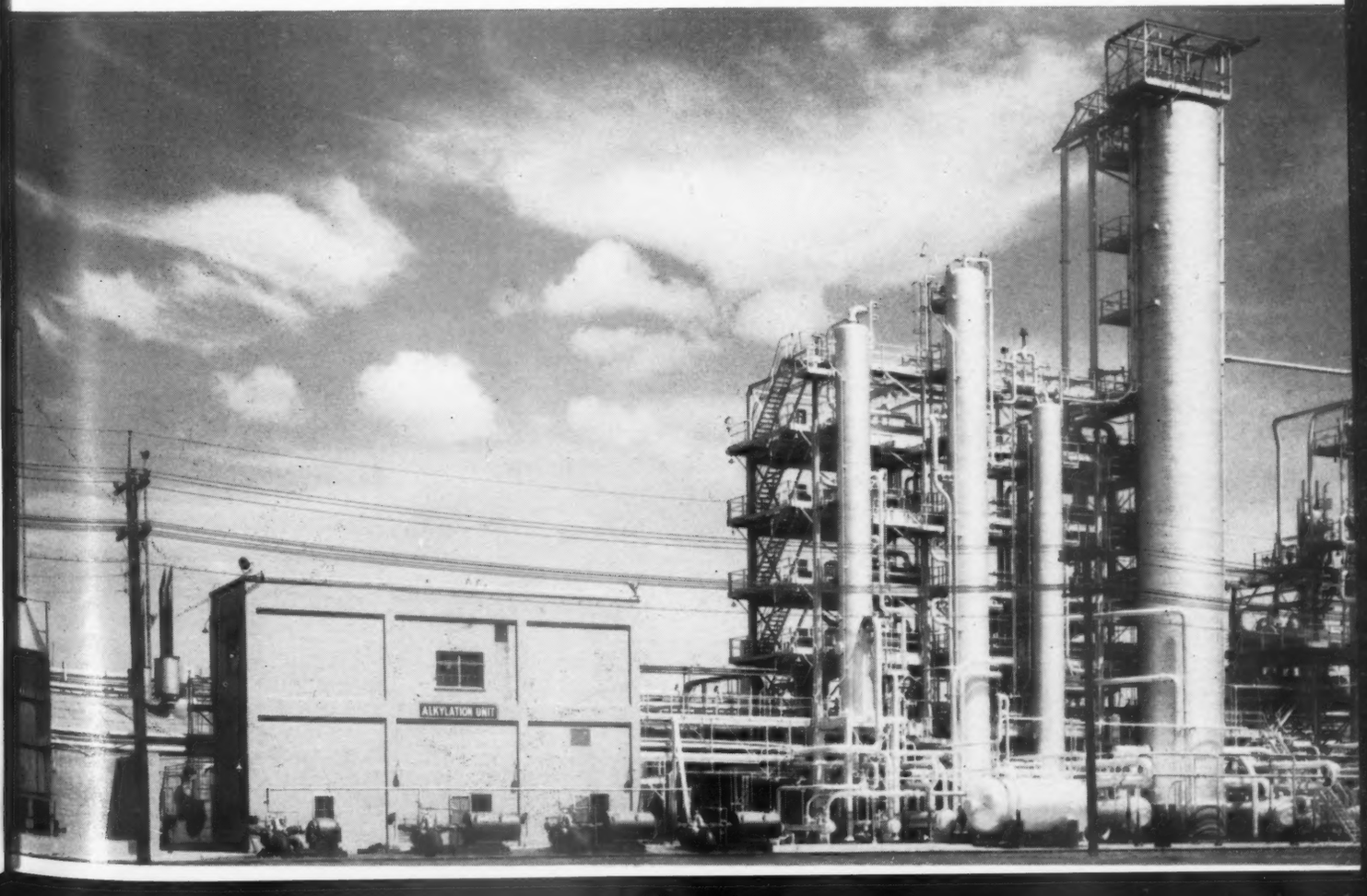
As an original member of the Polyco group, holders of the basic patents on the process, Kellogg has naturally been close to the process since its development. Its contributions include the creation of a special copper pyrophosphate catalyst that is regularly manufactured in Kellogg's Jersey City plant.

Top—Modern catalytic polymerization plant recently completed in the Westville (N.J.) refinery of the Texas Company. Bottom—Typical wartime alkylation unit designed and erected by Kellogg for Magnolia Petroleum Company at its Beaumont (Tex.) refinery.



In its work with light hydrocarbons, Kellogg has developed much valuable information included in these volumes on liquid-vapor equilibrium constants.




ALKYLATION UNIT

PHTHALIC ANHYDRIDE

One of the first applications of the Fluid catalyst principle outside the oil industry was for a plant designed by Kellogg during the war for the production of phthalic anhydride. This is done by oxidizing naphthalene at relatively high temperatures. Other major plants employing the Fluid process are now being engineered.

A recent one of these is a plant designed to produce 15,000 tons per year. This plant is designed to charge distilled liquid naphthalene and to produce crude phthalic anhydride. The process may be subdivided into two basic sections: Reactor and product recovery.

Distilled liquid naphthalene from storage is picked up by the feed pump, then mixed with a small amount of air and charged to the reactor.

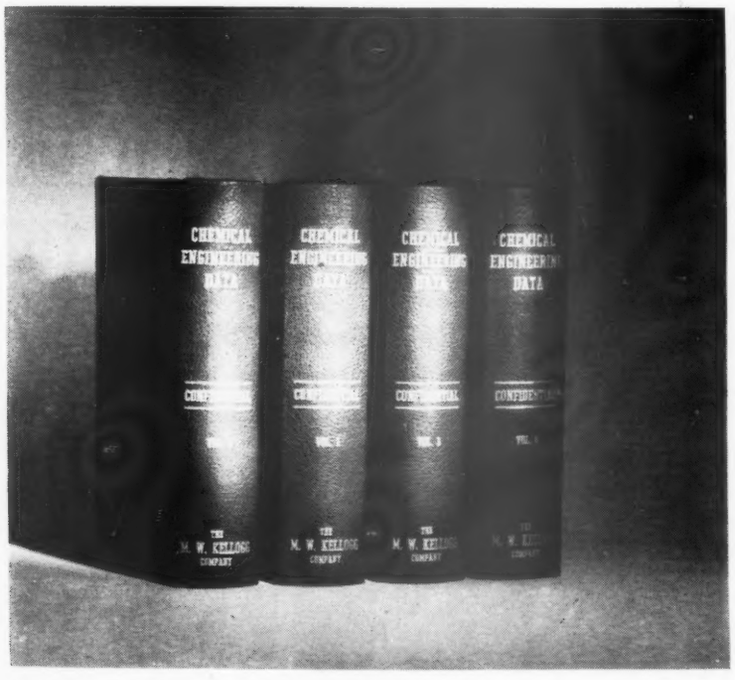
Entering the base of the fluidized bed, the vaporized material comes in contact with the remainder of the air and with the fluidized catalyst.

On leaving the top of the bed, the combined vapors of phthalic anhydride, excess air and other reaction products pass out the top of the reactor to a group of filters. These operate on a time cycle so that each filter successively is blown clean by air.

Vapors from the reactor filter vessels are cooled to a point just above the melting point. The phthalic anhydride is then cooled to the solid state in one of two condensers, each designed to handle an hour's production of phthalic anhydride. They are arranged for cyclic operation.

Photo Page C-54

In all catalytic reactions such as the production of phthalic anhydride, the study of catalysts is basic to the success and improvement of the process. In the picture on Page C-54 a Kellogg lab technician is studying the effect of temperatures on various types of catalysts.



Chemical engineering data such as collected in these volumes are an essential part of any processing design. Information includes data from operating plants, pilot plants, and other sources.

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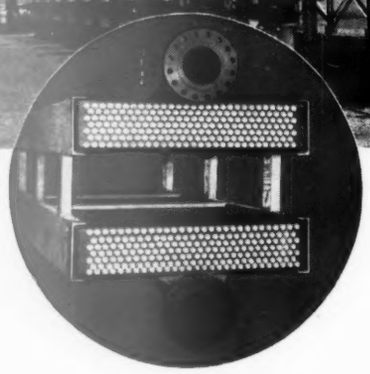

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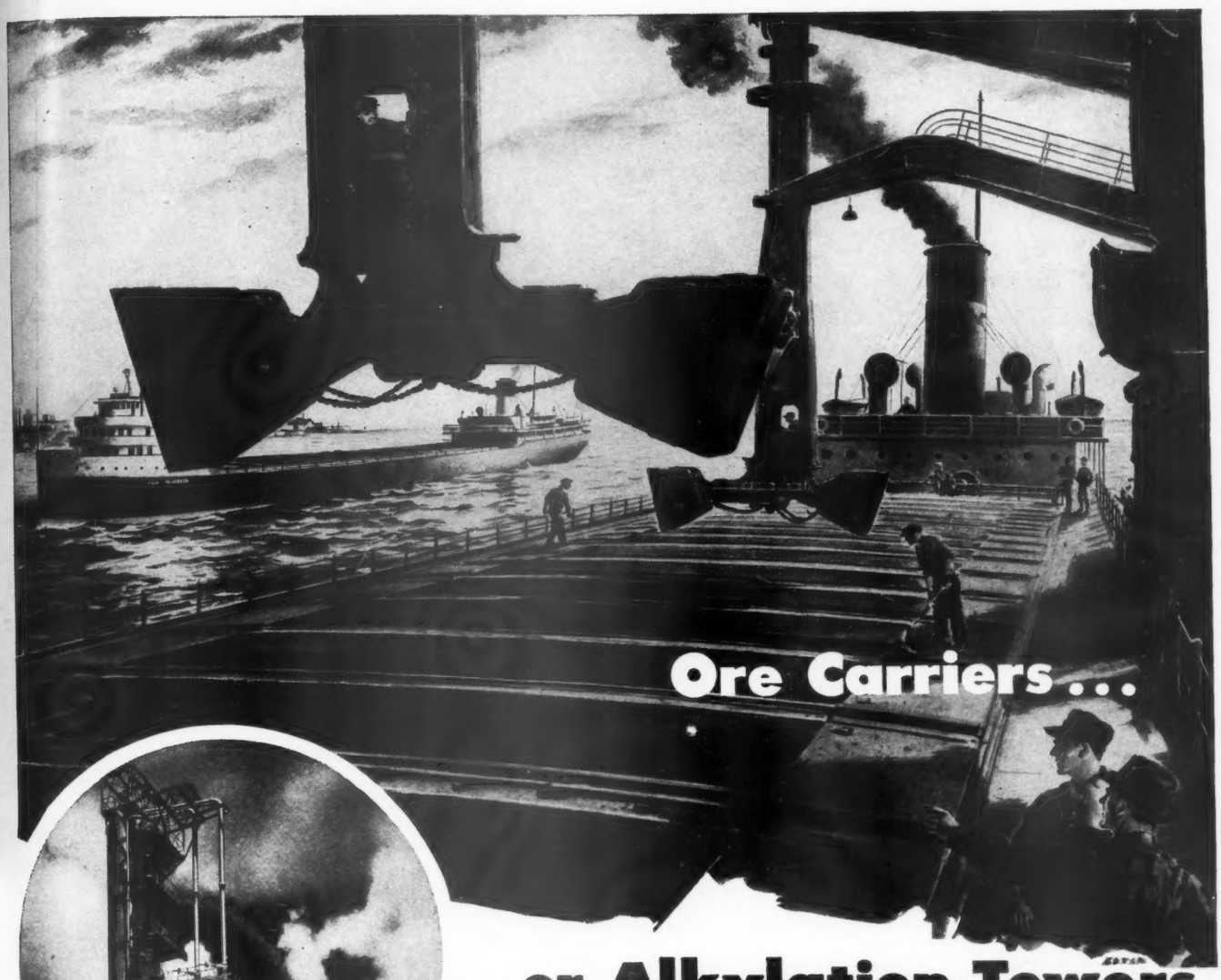

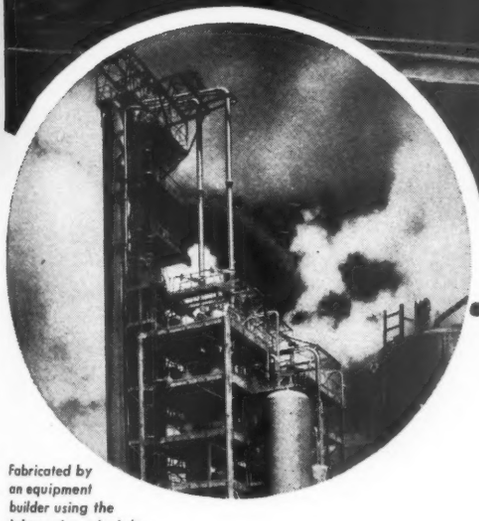

...or Alkylation Towers

Fabricated by an equipment builder using the Lukenomics principle.

Project records on this alkylation tower tell a typical Lukenomics story . . . excellent performance, lower costs, simplified construction. The problems presented were solved so well by the equipment builder's experience and his use of Lukens specialty steel plate, heads and steel plate shapes that seven similar towers have since been built. Particularly important now—the long life built into the equipment helps conserve strategic materials.

Whatever your project, it's important! Don't let today's restrictions kidnap efficiency. That's where progressive equipment builders can help. Delivering improved production, despite current conditions, is one of their prime contributions.

An important factor in this is their application of the Lukenomics principle. For Lukenomics combines their experience and that of leading designers and engineers with Lukens' specialized knowledge of materials, their production and application.

Get this *extra* attention for your project. We'll gladly put you in touch with equipment builders applying the Lukenomics principle. Just write, stating your problem, to Manager, Marketing Service, Lukens Steel Company, 571 Lukens Building, Coatesville, Pa.

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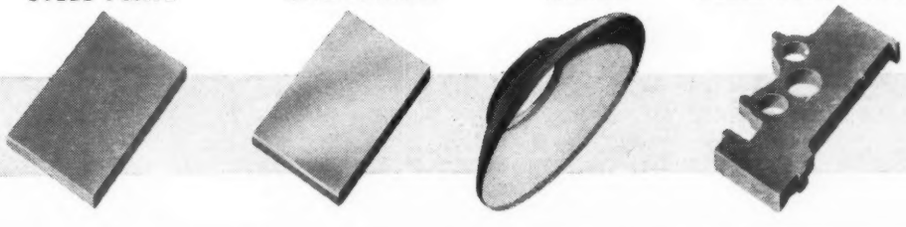


LUBE PRODUCTION

For many years refiners of lubricating oils with sources of low asphalt-bearing crude had a decided advantage over competitors without this so-called "select crude" supply. New methods for processing lubes, however—developed largely during the late 30's and early 40's—have equalized this disadvantage.

Today, due to the development of the familiar JUIK (Jersey-Union-Indiana-Kellogg) group of processes, particularly propane deasphalting, the complete removal of asphalt from reduced crude is a simple, inexpensive step—and asphalt has been eliminated as a measure of potentiality of crude for lube processing.

Many of these processes were either created or improved in Kellogg's laboratories. Today, they include all steps required in making satisfactory lube oils from all types of crudes. The steps include the following: Propane deasphalting, propane fractionation, phenol extraction, propane dewaxing and propane clay treating.

As the flow description of these processes is essentially familiar to all refiners perhaps it would be more interesting to discuss a few of the developments that brought about their basic value today.

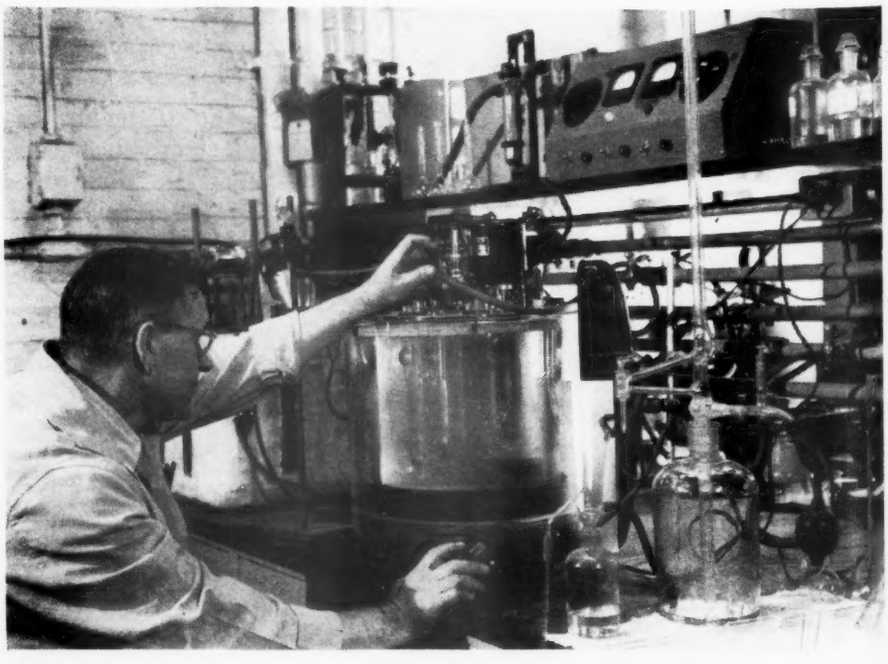
In speaking of propane deasphalting probably nothing this side of the basic idea, has had more to do with its success today than the development of the tower method as opposed to the original "stage" method.

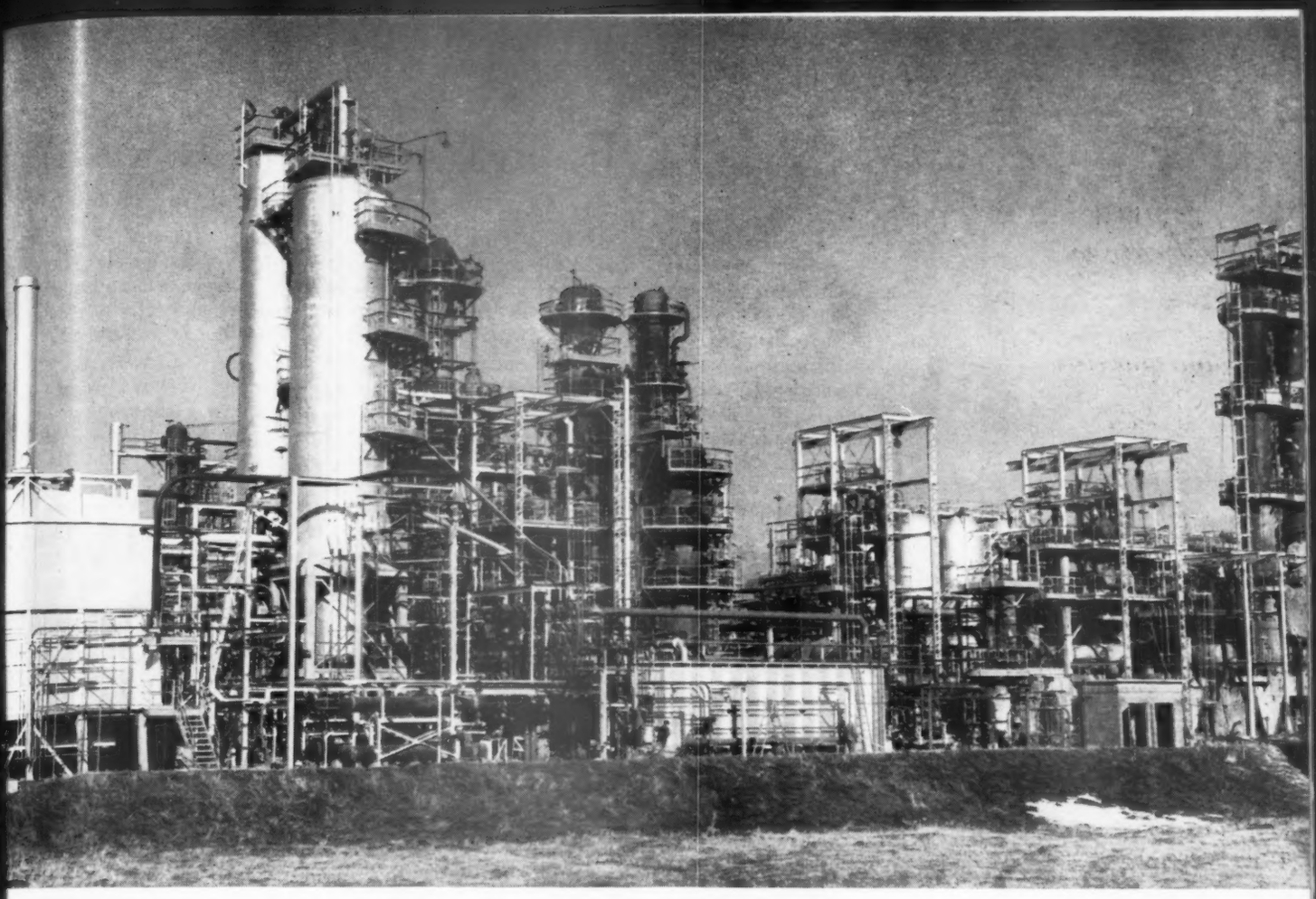
First utilized successfully as a settling process in horizontally positioned equipment, Kellogg later developed the present counter-current tower method. It is efficient, non-critical in operation and extremely flexible over a wide range of feed and product specifications.

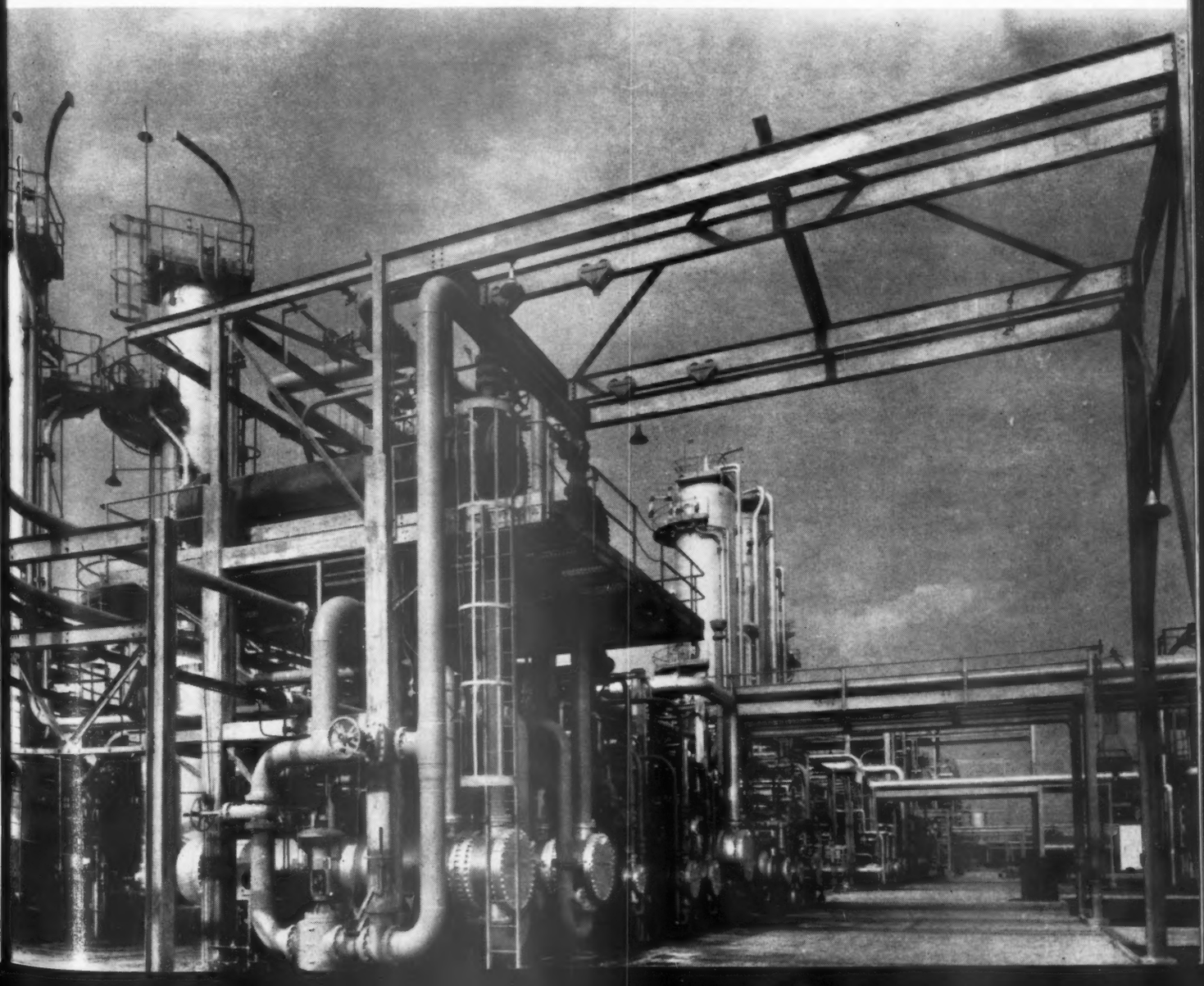
Phenol treating has been employed for many years for the purpose of improving viscosity index of lubricating oils. However, the development and commercial application of an unusually efficient, high capacity, countercurrent treating tower, and the successful application of the water rejection principle for improving treating efficiency have given this process an outstanding position.

Top—For Phillips Petroleum Company, Kellogg took a then-dispensable and inoperative alkylation plant and converted it into a complete lube plant. Bottom—Shown here is the exchanger section of the combination propane deasphalting and phenol treating plant Kellogg built for Shell Oil.

Pilot plant results are constantly checked in the laboratories. Here, a technician runs off a test on a viscosimeter.







KELLOGG
1901 1951
50th Anniversary
Commemorative Section of The Petroleum Engineer

ETHYLENE PRODUCTION

THE increasing use of by-product olefinic gases as fresh feed for petrochemical operations has been one of the outstanding refinery trends of the past decade. In the U. S., where throughputs are large, processing has consisted primarily of close fractionation of various desired gases. Much of North America's butylene concentration capacity for butadiene productions as well as several ethylene plants have been engineered by Kellogg.

Most recently, however, has been Kellogg's design of a unique naphtha pyrolysis plant in England, which produces ethylene and other olefins from low octane naphtha. This plant is now nearly finished just as another has been contracted for by an Italian firm—a unit that is expected to do much to strengthen Italy's chemical industry.

A brief process description follows:

Naphtha is charged to heaters and is then introduced to the pyrolysis section where it comes in contact with high temperature steam, during which time the cracking to olefins is accomplished. These vapors are then cooled to arrest the thermal reaction at the desired point. At the same time heat is recovered by producing large quantities of high pressure steam.

The mixture of cracked gases is fed to the primary fractionator tower for separation of polymers, which boil above the gasoline range. The vapor leaving the top of the tower passes through exchangers in which heat is recovered for use in the ammonia absorption refrigeration unit. The vapors are cooled further in condensers, separated into gas and gasoline. The gases are compressed and then sent to the recovery and fractionation section. The gasoline is charged to a debutanizer tower.

The uncondensed overhead product from the debutanizer, comprising propylene and lighter, is introduced to the main gas fractionating system. The B-B product is withdrawn as a sidestream and caustic washed to remove sulfur, whence it goes to storage. The debutanized gasoline is charged to gasoline treating facilities.

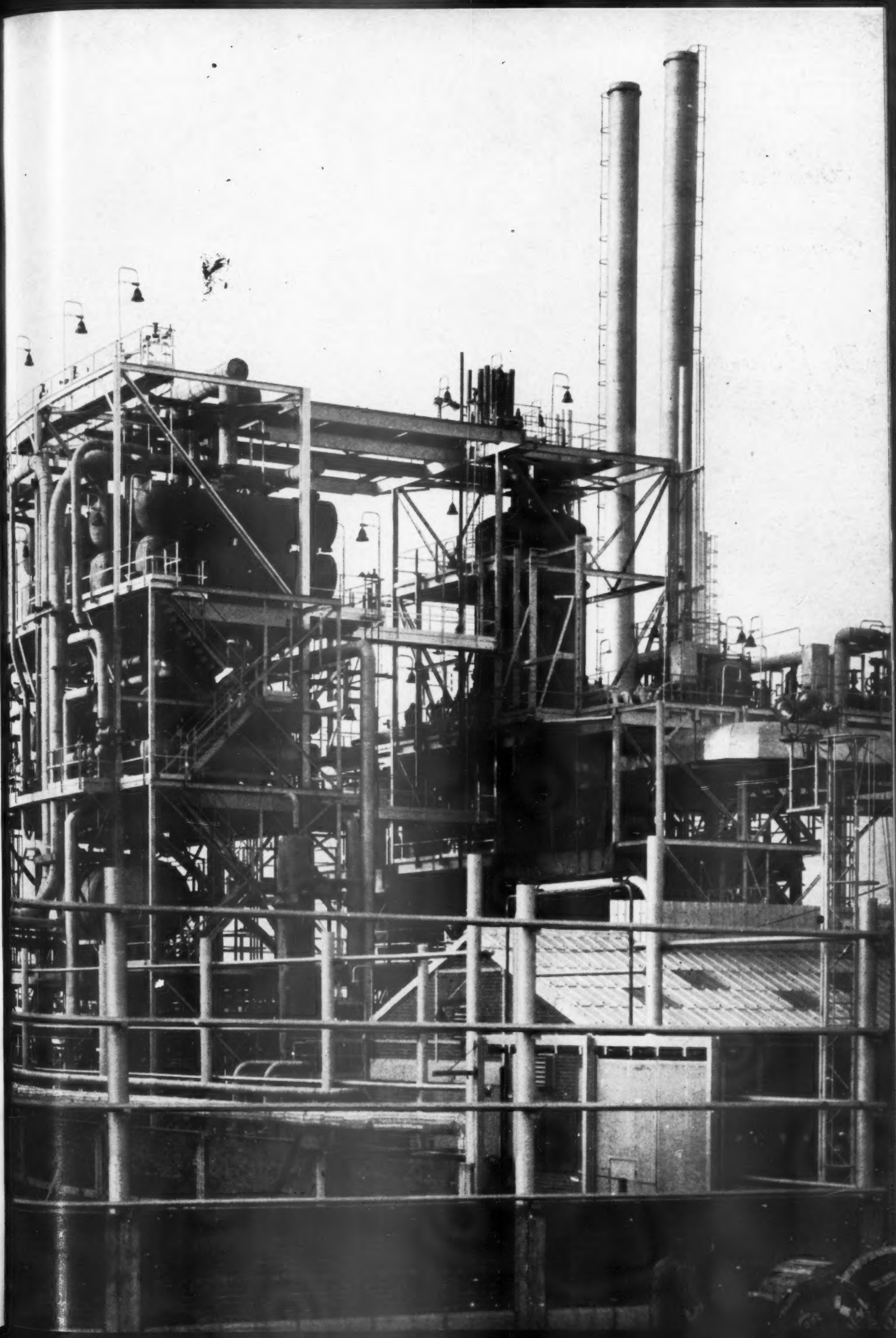
After compression the gases from the primary fractionator and from the top of the debutanizer are passed through a sulfur removal system. They are then caustic washed, cooled by ammonia refrigerant.

The vapors are charged to an acetylene removal system and a gas drying step. They are then fed to the depropanizer tower. This fractionator takes off the propane and lighter as overhead product, while the remaining butylenes and heavier are taken off as bottoms.

The overhead gas product from the depropanizer is charged to the demethanizer. Overhead product from this tower is tail gas. The bottoms comprise a mixture of ethylene, ethane and propylene, which is pumped to the deethanizer tower. Here the propylene is separated from the ethylene-ethane.

The ethylene-ethane mixture is fractionated to produce an ethylene product of high purity.

Right—After cooling the pyrolyzed mixture of hydrocarbons is charged to the primary fractionator, shown here in back of the pump shed.



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AMMONIA

TOTAL U. S. production of anhydrous ammonia, a primary component in explosives, was augmented during World War II by Kellogg's concentration of two complete ammonia plants. These employed many engineering features not included in plants then existing. They set new efficiency levels for the industry. Concurrently, Kellogg also engineered and constructed a similar plant in Canada.

Typical of the process is a plant engineered to produce 150 tons of ammonia daily. The primary process feed materials for this unit are sulfur-free natural gas, steam, and air. A special desulfurization process is used to prepare the natural gas. Raw synthesis gas is produced in a pressure steam-natural gas reforming furnace followed by a combustion chamber where nitrogen in the form of air is introduced into the system.

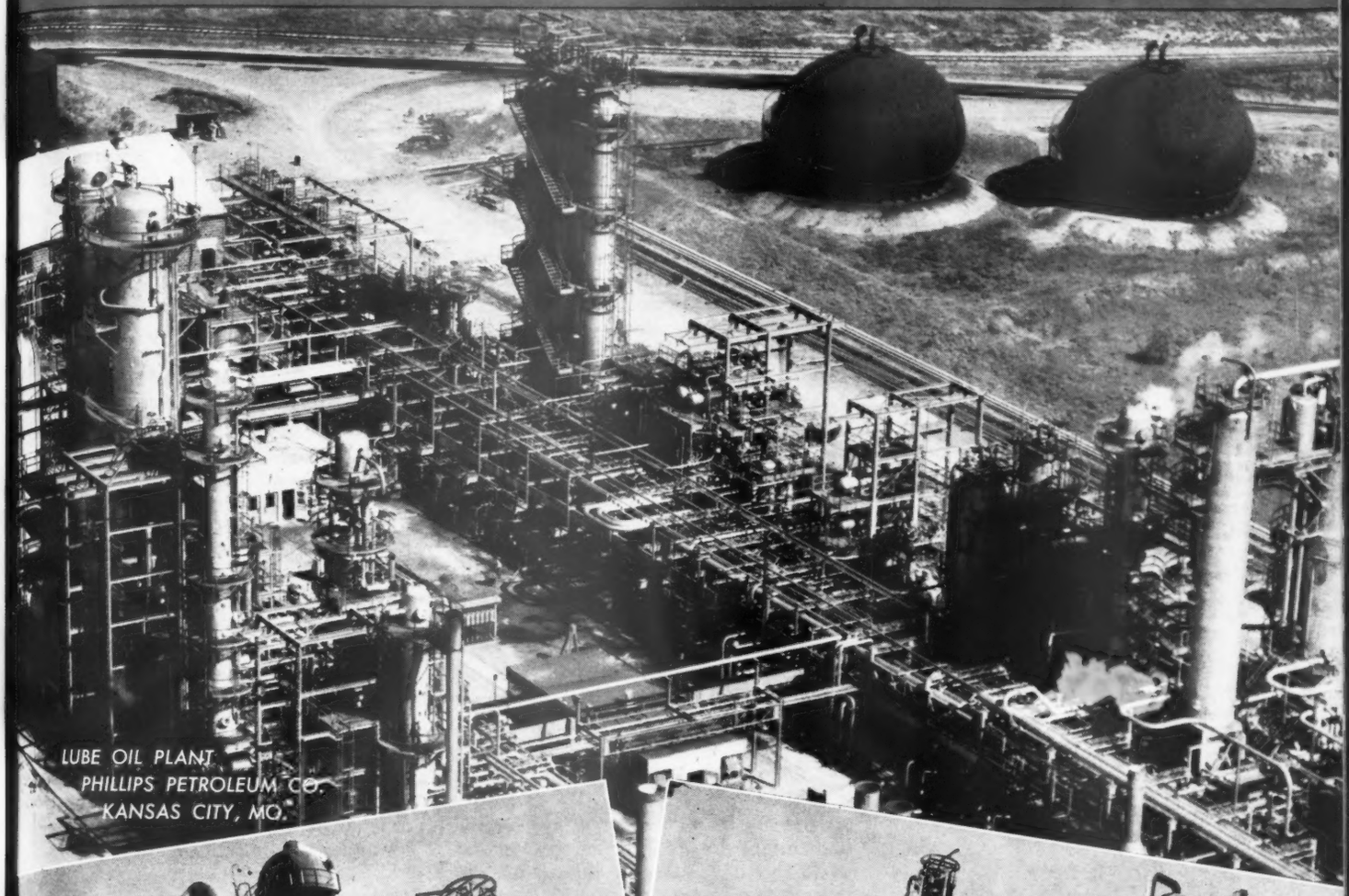
The furnace reforms a large proportion of the natural gas. In the combustion chamber air is mixed with the partially reformed gas to supply the desired proportion of nitrogen in the synthesis gas. The heat of combustion of the oxygen in the air supplies the energy required to reform the remainder of the natural gas. The synthesis gas from the chamber is then pumped to a quench drum. The effluent from this drum is charged to a carbon monoxide converter where most of the CO reacts with water to form carbon dioxide and hydrogen. The carbon dioxide removal step follows this operation, in which a regenerative aqueous monoethanolamine system is employed to remove the CO_2.

The synthesis gas then goes to a CO stripper which, at high pressure, removes any residual oxygen, carbon monoxide, and carbon dioxide. From here the synthesis gas, a mixture of hydrogen and nitrogen, is pumped to the ammonia catalytic converters after being compressed to about 4000 psig. Product gases leaving the converters are cooled by water and then by exchange with the converter feed gas in the recycle gas exchangers. Anhydrous liquid ammonia is separated out in the primary separators and after further cooling in the chillers goes to the NH_3 product drum.

It is in these high pressure converters—like the large cylinders shown here partially obscured by piping and steel work— hat the synthesis gas is catalytically composed into ammonia.

Engineered by Kellogg

LUBRICATED VALVES BY NORDSTROM



LUBE OIL PLANT
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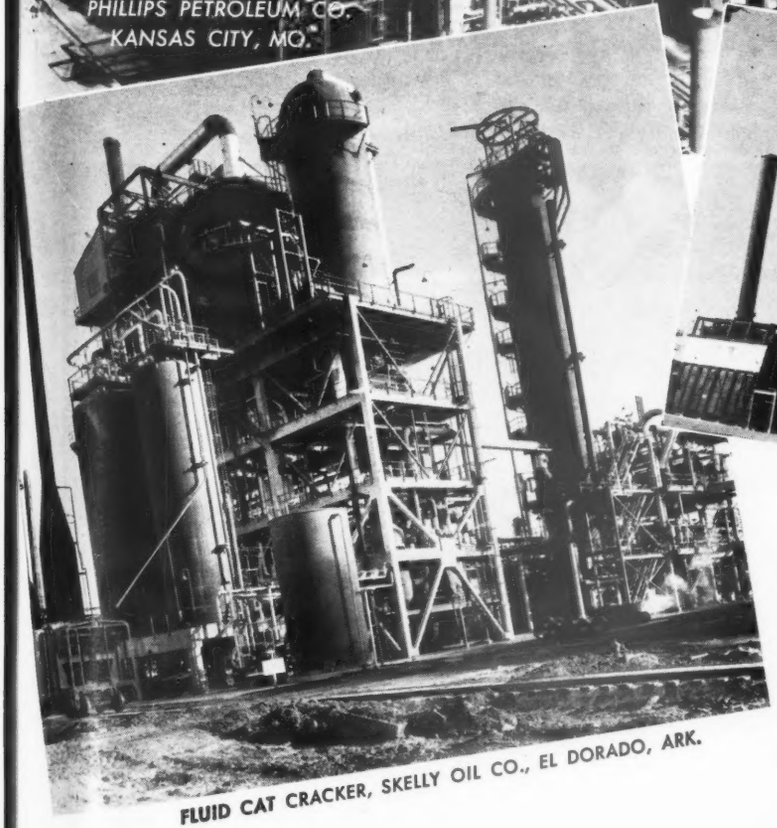
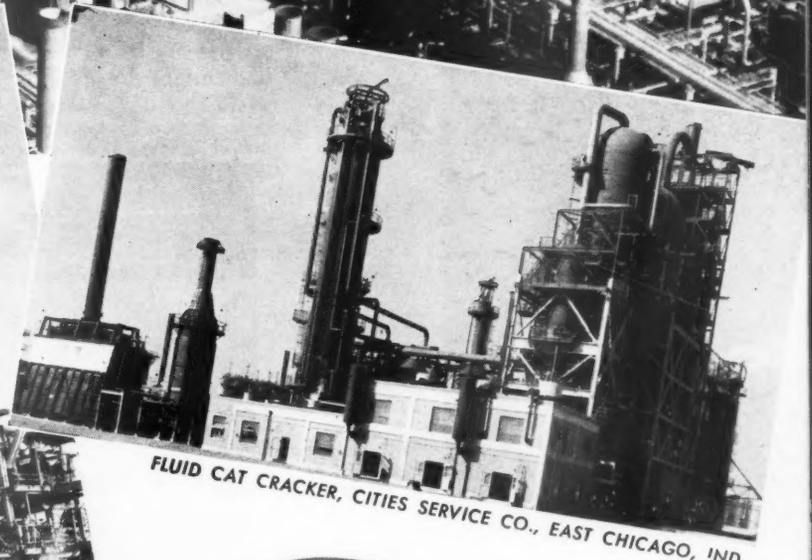
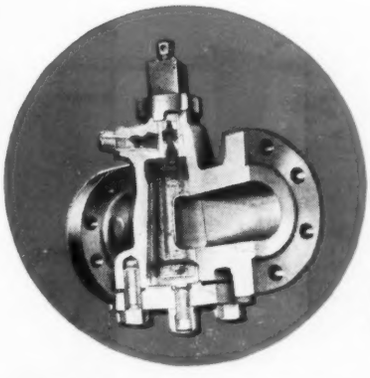
KANSAS CITY, MO.



FLUID CAT CRACKER, SKELLY OIL CO., EL DORADO, ARK.



FLUID CAT CRACKER, CITIES SERVICE CO., EAST CHICAGO, IND.



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Nordstrom **LUBRICATED VALVES**

BUTADIENE

In view of the present reactivation of several synthetic rubber plants, butadiene is again in the news. It was also in the news during the early 40's, when the oil industry radically increased the supply of synthetic rubber through the catalytic production of butadiene by dehydrogenating specially purified butene. At that time Kellogg engineered and constructed butadiene plants in both the U. S. and Canada—plants with a total capacity of 270,000,000 lb per year.

It is one of the most complex catalytic processes. Space will not permit even a simplified flow description. A brief outline of the physical and chemical reactions employed in the process may be of interest, however.

Feed to the processing equipment is a mixture of several 4-carbon-atom hydrocarbons. Not all of these are convertible to butadiene and must be removed before the conversion step.

Iso-butene is removed first. As certain concentrations of sulfuric acid will preferentially combine with this hydrocarbon, the mixture of petroleum gases is first contacted intimately with H_2SO_4. The resultant mixture of isobutene and acid settles out from the remaining hydrocarbons.

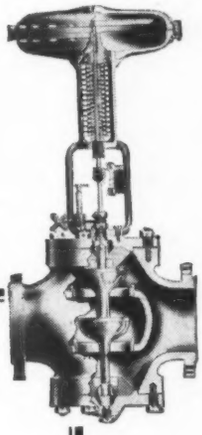
The isobutene-free mixture is then caustic washed to remove any acid that might have been carried over from the treating stages. It then passes through the stage in which the normal and isobutane are removed. This separation of butanes and butenes is accomplished by extractive distillation in a solution of acetone and water as the extractive agent. In operation the acetone solution widens the very narrow spread in boiling points between the butanes and butenes and permits their separation in a fractionating column.

Broadly speaking, the butenes are now ready for conversion to butadiene, a step that is carried out at high temperatures, low pressures with steam in the presence of a catalyst. Following this dehydrogenation step, the mixture of unreacted butenes and butadiene is cooled quickly to prevent polymerization of the butadiene. Butadiene is separated from the mixture by extracting it with a water solution of cuprous ammonium acetate. Butadiene is released from this solution by heating.

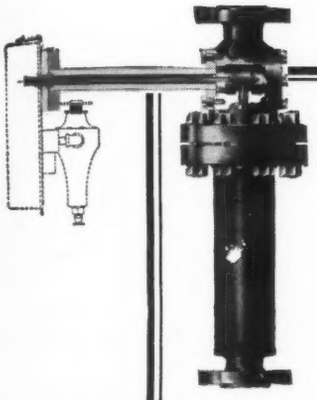
Any process as complex as butadiene production with its close fractionation and narrow spreads in the boiling points of the materials being processed requires fundamental knowledge of fractionation. In its Lucite bubble tower, Kellogg is able to make visual studies of fluid dynamics under varying physical conditions.

Experimental tower made of Lucite for study of fractionation.

Your Process Is Only as Good as Its Controls . . .

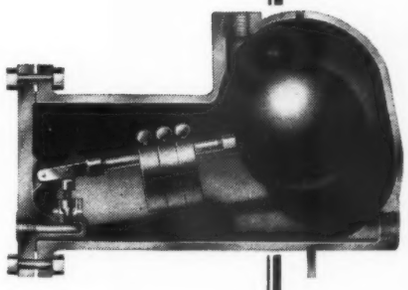


Control Flow, Temperature, Pressure or Liquid Level of air, gas, vapor, liquid or steam with BS&B "Climax" Type 86 Diaphragm Control Valves. Wide yoke for easy accessibility to packing gland. Long, multiple springs. Three point roller bearing guides for upper stem minimize friction. Adequate diaphragm areas to increase power of diaphragm operation. Super-polished lower stems . . . bolted down yoke increases strength. Sizes ½ to 16 inches, 125 to 5,000 psi.

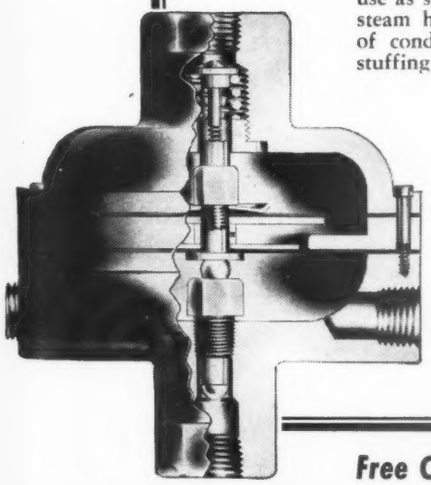


Newest Liquid Level Control, BS&B "Climax type 888, featuring new *cone point pivot* . . . rugged, friction-free, easily replaceable in the field. Torque tube housing is removable and reversible without dismantling controller housing. Heavier walls and flanges for greater safety. Perfect alignment with male-female flange connections throughout. Now you can install two torque tube housings and two pilots and/or pilot and switches for simultaneous level control and alarm operation. Any combination of equalizing connections . . . vertical, horizontal or combinations.

Controls You Can Count On . . . the BS&B "Climax" Line!



Duo-gravity Continuous Drainers, BS&B "Climax" type 91, one of a series designed for continuous drainage of water, condensate or oils from systems operating under pressures up to 600 psi. Ideal for use as steam traps on fractionators, reboilers or other steam heated equipment where constant elimination of condensate is required. Highly accurate because stuffing boxes have been eliminated.



Get Greater Speed of Action with the new BS&B "Climax" Relay, type 227. This delayed-action, fixed-ratio relay is best suited for use with series-operating diaphragm control valves in "split ranges." Permits full valve travel with primary control pressure changes as low as 2 or 3 psi. Other relays reverse action, 1-1 ratio, fixed and variable ratios.

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EFFICIENCY BS&B "Climax" RELIABILITY

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SYNTHOL

In a recent contract for a plant in Africa, Synthol—a process for the synthesis of gasoline from carbon monoxide and hydrogen, which has been under development in Kellogg Laboratories for two decades — reached commercial fruition. The theoretical chemistry of the process is generally known to all who are familiar with the Fischer-Tropsch method. But Kellogg's design is a considerable extension and improvement over the original process.

The Kellogg Synthol process can use carbon monoxide and hydrogen produced from either natural gas or coal. For the production of carbon monoxide and hydrogen from natural gas, Kellogg has greatly improved the reforming reaction of methane and steam. For the South African Synthol plant based on coal as the source of carbon monoxide and hydrogen, Kellogg is going to use the Lurgi pressure gasification system. This system has been selected as the coal gasification process because it is the only system that has been operated on a commercial scale on many types of coal. The Lurgi gasification process brings coal of any size in contact with steam and oxygen. The ratio of carbon monoxide to hydrogen is controlled by the ratio of these reactants.

Following this step, the manufactured gas is charged to the cooling plant which removes entrained tar, water and oil. A further step takes out all hydrogen sulfide. Since the gas from the Lurgi generator contains relatively large percentages of methane, the gas is then pumped to a reforming section where the methane content is adjusted.

The hot reactor gases are cooled by heat exchange and steam production to about 120 F. Water is removed in knock-out drums and the synthesis gas is charged to the Synthol reactor, where it is converted to hydrocarbons and chemicals in a fluid catalyst system. The gas is mixed with a recycle gas stream and a hot catalyst circulating stream to give the desired reaction temperature.

Product gas stream from the reactor passes to a waste heat boiler and to a catalyst scrubber tower for partial condensation of the heavier hydrocarbon and chemical products, which are taken off as bottoms.

Scrubber overhead is cooled and separated into a gaseous phase, an oil phase, and a water phase. The major portion of the gaseous phase is recycled back to the reformer. The oil phase is water washed, joins with the heavier hydrocarbons produced as bottoms, and both proceed to the hydrocarbon recovery and catalytic polymerization section where mainly finished gasoline and diesel oil are produced.

Most recent of Kellogg's several Synthol pilot plants, below. It operates 24 hours a day, seven days a week providing a continuous flow of process data which are currently being translated into commercial reality for SASOL.

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PETROLEUM INDUSTRY

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HOW A GREAT ENGINEERING ORGANIZATION OPERATES

As MAY BE EXPECTED in the nature of the case, increased complexity in technology, construction, and operation of a refinery has had its counterpart in the growing complexity of an engineering organization built up over a half-century to develop, design, and build the units making up today's refinery. That is eminently true of the Kellogg engineering department.

Briefly, the department responsible for the company's design, construction, and test operating work is shown schematically in the accompanying Figs. 1 and 2. The first chart shows the 6 main subdivisions under the director of engineering: (1) process engineering, (2) project engineering, (3) design engineering, (4) administrative engineering, (5) mechanical development, and (6) engineering standards. The number of groups under each of these varies, as their functions differ radically.

For example, design engineering has 7 groups covering the main phases of design: Piping, furnace and vessel. heat transfer, structural, electrical, equipment, and instrument. Mechanical development and standards are not subdivided.

Fig. 2 shows the main control lines or connections within the departments that enable management to concentrate the efforts of all groups on each individual contract. Heavy lines show how each job is headed up by a project manager who has full responsibility to the customer. Job engineers assist him and channel work out and results in from specializing groups.

Under the Kellogg system, every job entering the design engineering phase, after process engineering has been approved, goes *first* to the plans and analytical groups. It is the function of these specialists to fix within narrow limits all of the variables that will affect detailed mechanical design. These they prepare and have approved by the customer. Their initial work includes such basic design information as plot plans, elevations, piping layouts, utility plans, and material specifications.

Process Engineering

The talents of three different types of process engineers go into most new refinery construction. These include the refiner's own process engineers, who have the intimate knowledge of their refinery's operation and requirements. Then there are Kellogg's two types of process engineers: The overall process engineer who works primarily with sequences of processes and the unit process engineer who concentrates on one refining process.

The process planners at Kellogg figure out alternate sequences of processes that will produce the desired yields. With this accomplished, the economics section of the process engineering department approaches the problem. This section formulates very

All these engineers devote their time exclusively to piping engineering at Kellogg. They occupy an entire floor in the New York offices—some 14,000 sq ft of space.

FIG. 1.

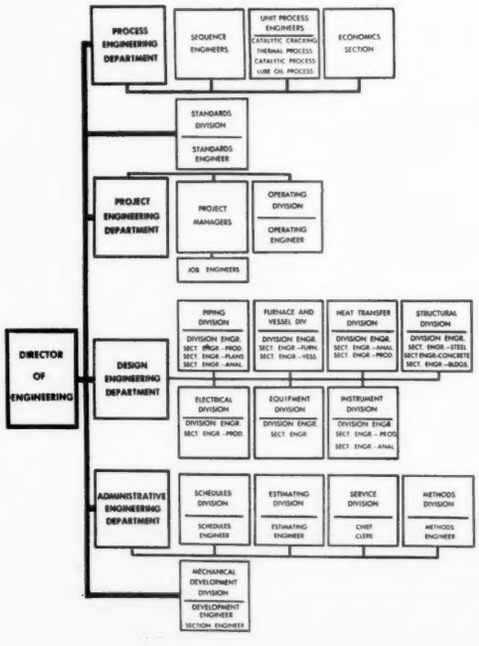
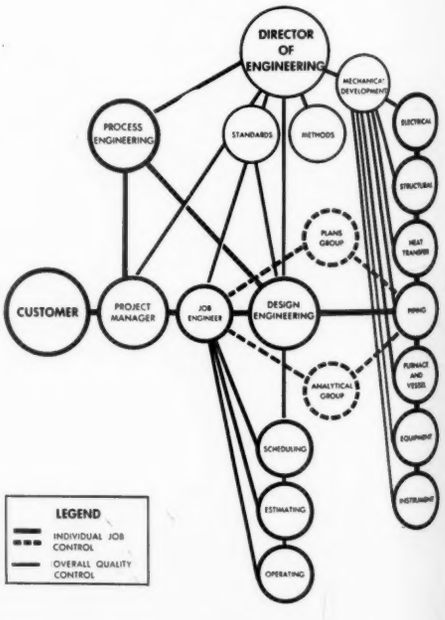
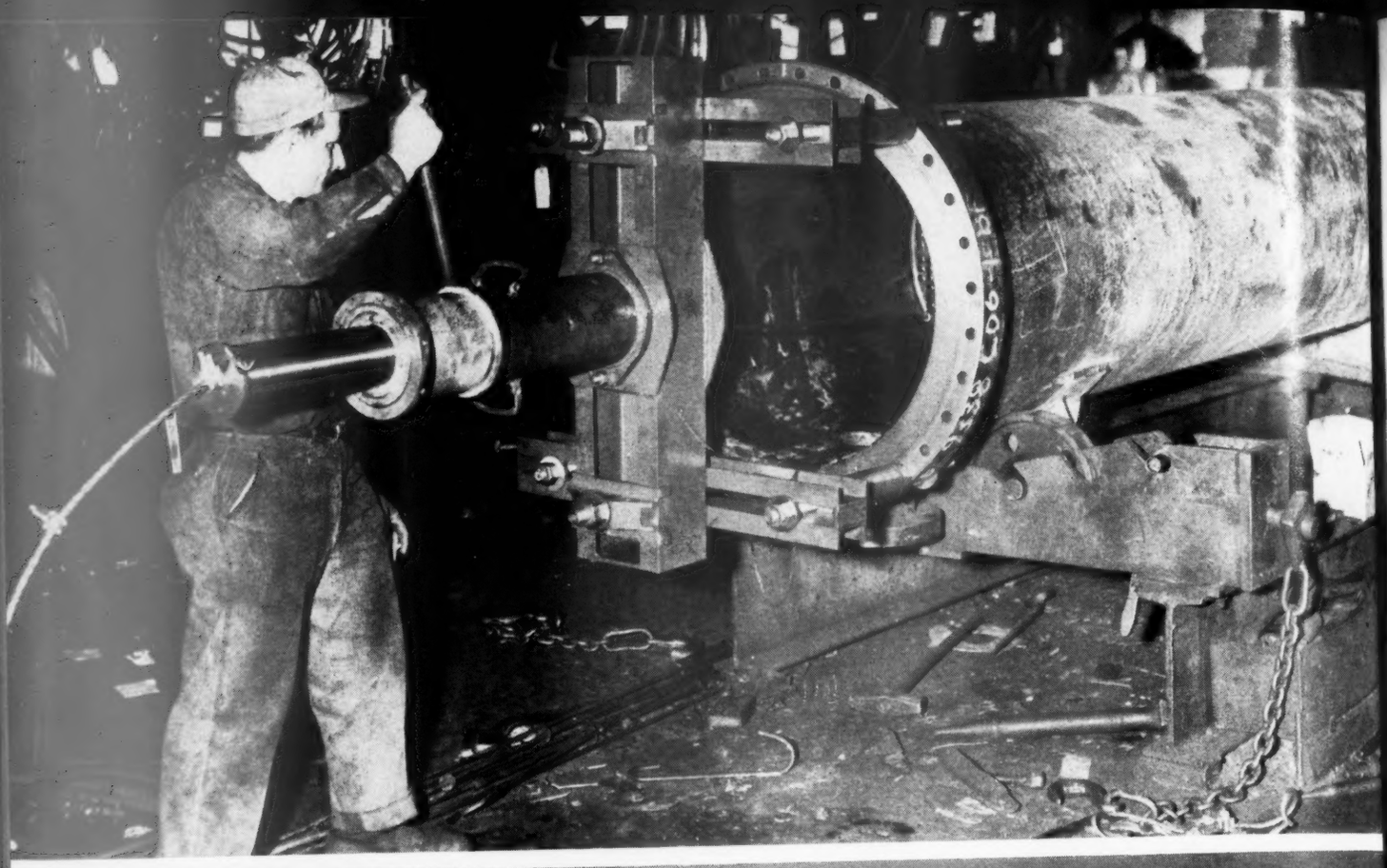
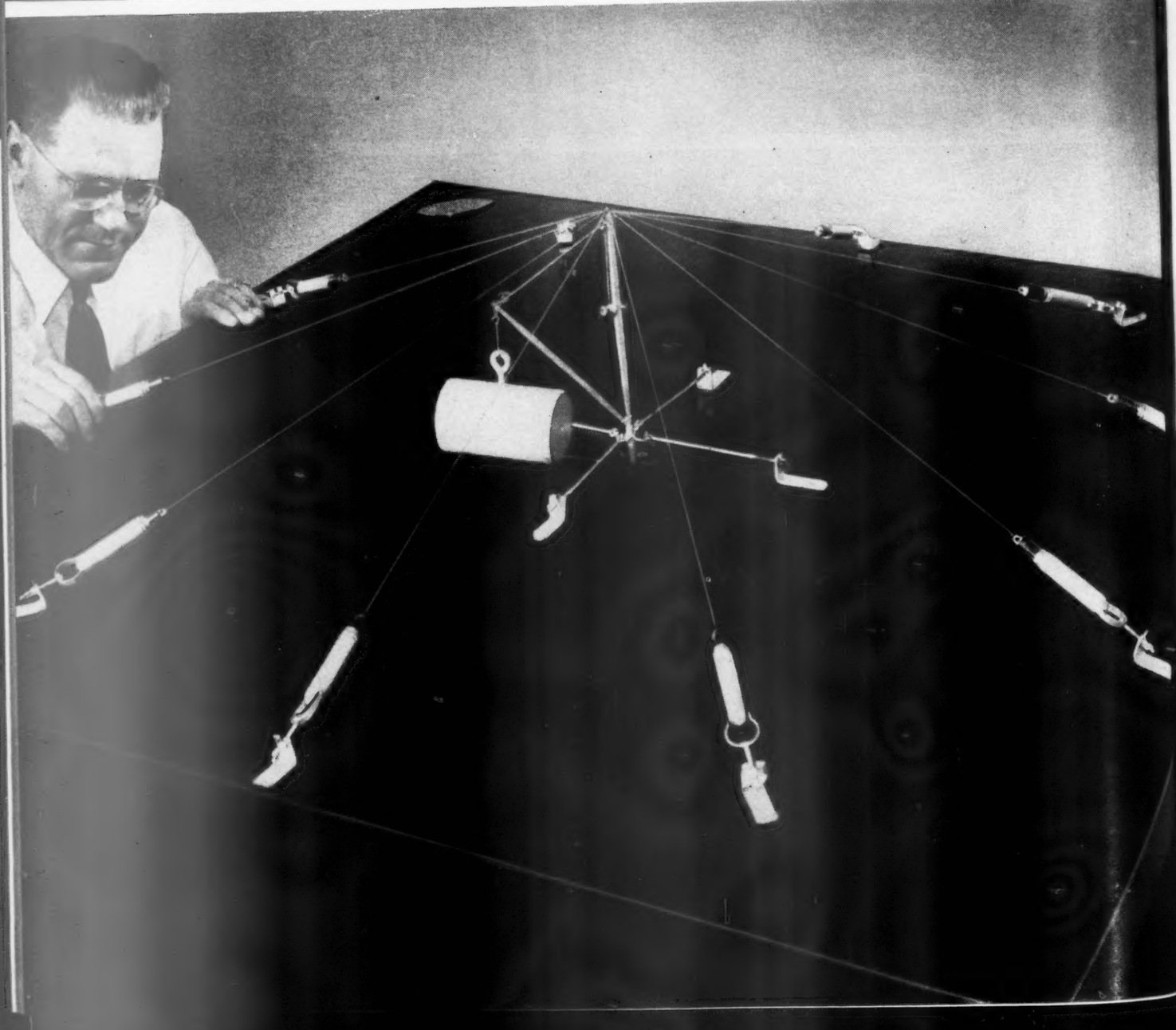


FIG. 2.







Left—A new method of removing heat exchanger bundles is typical of the work of the Mechanical Development Group. This device is a modified commercial, center-hole, hydraulic puller.

Below left—Kellogg introduced guy derricks for the erection of refinery equipment in 1932, with installation cost saving of 18 per cent. This scale model is used to analyze stresses in guy lines.

carefully calculated economic analyses of each of the alternate process plans.

Special considerations may be given to the subject, such as special pilot plant or even commercial plant runs to obtain specific data. The results are made up into one or more proposals.

These proposals are prepared in considerable detail and are submitted to the contracting refiner who chooses the one best fitted to his individual purpose.

Once a process plan has been approved by the refiner, it becomes a project. The work of process engineering is parcelled out to the unit process engineers specializing in each particular process. These men develop the detailed process design.

Frequently, the chemical engineering development group and the pilot plant laboratories are brought into the picture to provide more information for the purpose of design.

The process engineering department supplies project engineering with an assembly of all required information in a process data book, which gives all information as to chemical properties of stocks and streams, temperatures, quantities of material at all points in the system, utilities needed, equipment sizes, etc.

Project Engineering

Coordination of individual contracts is the specific job of project engineering, the chief of which makes up a design policy memorandum outlining the main features of the job, points that are considered critical or on which special attention is to be expended. The project manager approves the process layout, releases it for design and maintains liaison with the customer. Project manager and job engineer prepare the specifications for the work, and when design begins, the schedules engineer works out a timing schedule based on the exigencies of the work.

Receiving the Process Data Book, the design engineering staff, as mentioned earlier, gets to work. Recently this entire setup has been reorganized with two major innovations. More authority has been given to the plans and analytical groups, looking to closer liaison with and control of all design activities; and the management of and responsibility for all projects is assigned to a project manager, chosen from among the most experienced of Kellogg's men.

The job engineer assigned to the work turns over the Data Book to the plans and analytical section, which plots the refinery or the unit.

Through the many years, the company has developed standard specifications for a great number of items of equipment and material, of procedure, and process details. Development of these standards is the work of the standards committee of which the standards engineer is chairman. The director of engineering is a member of this committee as are representatives from all divisions. The committee reviews all standards before they are issued, organizes subcommittees for special study of problems whenever such is needed on any specific subject or specification.

In earlier practice, these standard specifications were taken as recommendations without "the force of law" in the company's work. Since reorganization, the department of design engineering must follow the standard "specs.," except by specific request of the customer, or because of unusual conditions as determined by the project manager.

As an important aid in establishing standards, the mechanical development division works with the standards engineer. This development division carries on a systematic program of mechanical engineering investigation in all phases of the company's mechanical engineering efforts, to develop new ideas, improve old ideas, and to build up continuously the standard of engineering endeavor of the company. This work includes every phase of the company's activities in mechanical engineering, whether it be insulation, catalytic cracking unit cyclones, methods for steam-tracing product lines, the design of a cheaper, more durable check valve, or more economical ways to pull exchanger bundles.

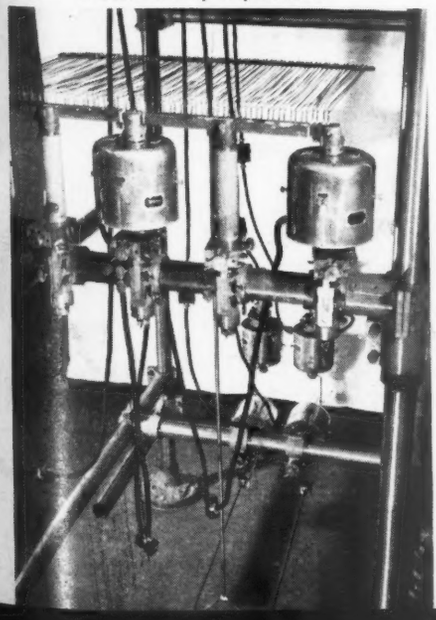
Among other men and groups in the design department is the cost estimating engineer, an extremely important post. This engineer must know or be able to estimate closely every phase and item of a job, from the smallest to the largest piece of material. He must have records, and must be familiar with them, to show these costs and the trends of prices; in a period of rapidly changing price structures, he must be able to project, with reasonable accuracy, the prices that will prevail at a date in future when the specific job is on the construction lot.

Another very important member of the engineering organization is the methods engineer. He carries out a systematic codification of the common technical standards employed by the organization, and also of the department's operating procedures.

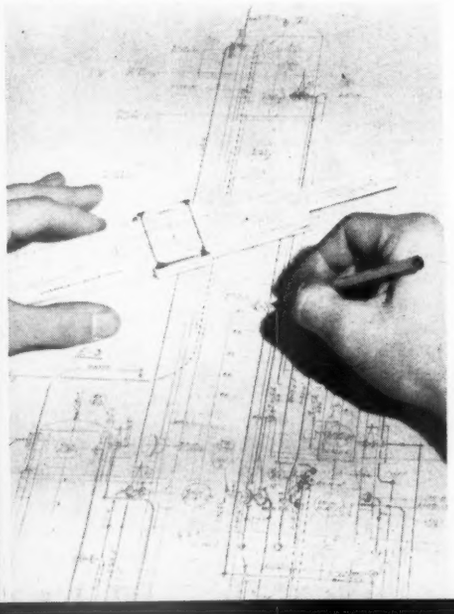
When the new unit is ready to "go on stream," the operating engineers take over and supervise initial operation. That is the crucial test of all the work done up to that time. On the results of operating the unit depend the customer's acceptance of the job.

These operating engineers live closer to actual refinery operating techniques than any other members of the Kellogg organization. They advise with the other departments about all matters pertaining to operations, the performance of equipment of every kind in service, about new developments that may be employed.

On this piping model tester Kellogg engineers are able to predict actual operating stresses in the most complicated power piping systems. To calculate mathematically such stresses is economically impractical.



This slide rule was created by Kellogg engineers for the purpose of rapidly computing vapor and liquid flow through process piping of varying diameters at different temperatures, pressures, gravities and viscosities.



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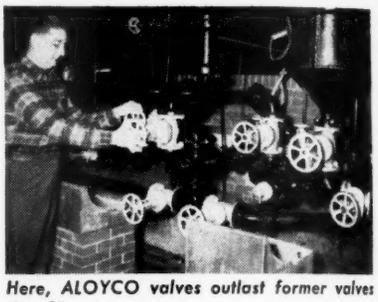

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The extraordinary service life of this ALOYCO gear-operated high-pressure gate valve . . . operating under severe corrosive conditions . . . is the result of a unique manufacturing service which includes:

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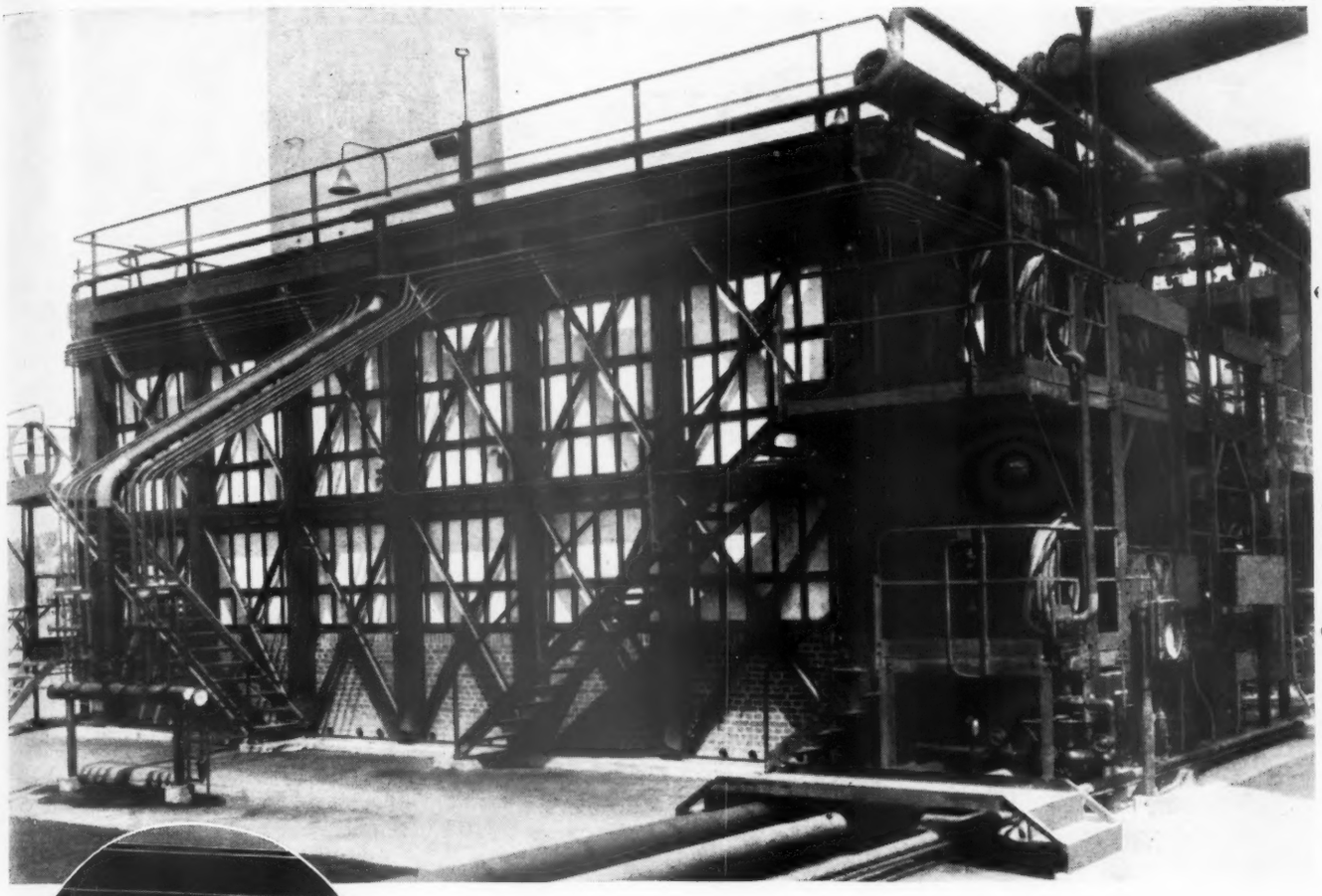
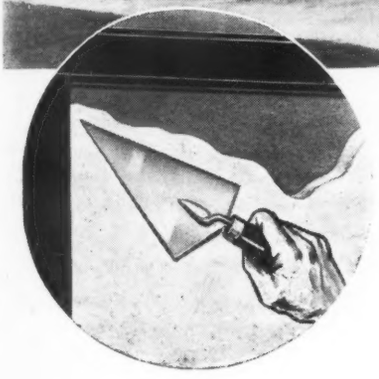
B. foundry and machine shop facilities set up for high alloy valves *only*;

C. casting and machining practices dictated by the difficult characteristics of the alloys required for corrosive services.

Longer Lasting
ALOYCO VALVES
1st in Corrosive Service





Weatherproof casing applied with a trowel directly to the insulation. Avoids need for steel casing and presents a neat appearance.

Engineered for Long Service

Designers of oil heating units have found Detrick suspended walls and arches a tool that is flexible. Here is a heat enclosure that can be applied to any contour: vertical, horizontal, sloped, curved, and even conical. In a heater the tubes may be placed at the most effective point without interference from the supporting elements in the arch and wall.

Detrick engineering offers a variety of constructions providing refractory face to resist high temperatures, insulation to stop heat, suitable supporting structure and an outer casing applied with a trowel which avoids the necessity of a steel casing.

Assurance of lasting service from Detrick enclosures comes from nearly 40 years of practical experience on all types of heating units in every industry.

A great deal of what has been learned throughout the history of the art of enclosing heat is included in the new book now being prepared under the title, "Heat Enclosure Methods by Detrick." Whether you have an immediate problem or not, send for a copy of this book which will be sent to you when published.

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Manufacturing Covers Many Products in Kellogg Shops

FROM huge vessels to plastics, from power piping to special alloy steels and catalysts, Kellogg's Jersey City shops manufacture a variety of products for many industries. The volume of the business, however, is in the metal fabricating end of the operation.

As a quick overall view, the Kellogg fabricating installation is capable of turning out many thousands of tons per year of finished equipment. This production is divided between the vessel fabricating division, heat exchanger division, and the piping division.

The heat treating facilities at Kellogg's Jersey City shops are among the most outstanding and varied in the fabrication industry. Six furnaces of various sizes are available for as many different sizes of equipment, the total 'heat treating volume' being of the order of more than 35,000 cu ft. All these furnaces except the longest are designed for operations up to 2000 F. This largest furnace will handle at one "sitting" a vessel 12 ft in diameter and 80 ft long; analogously, the furnace handling the largest diameter will treat a unit up to 18 ft, by 23 ft length. With these six units all heat-treating requirements for any required equipment are met very satisfactorily.

Indicative of the type and size of work done in these shops is the production of a fully stress relieved fractionator 16-ft internal diameter and 120 ft long. Another fractionator of the same diameter but built of clad steels, the lower section clad with 11-13 chrome, upper parts monel-clad, has been fabricated.

Similarly, boiler drums up to 60 in. diameter, 4 1/32-in. wall and 40 ft long have been fabricated, X-rayed, and fully stress-relieved in the shop. Vessels up to 45 ft in diameter and too large to ship completed have been fabricated, match-marked, disassembled, shipped, and reassembled on the job. Some large vessels, including the large fractionators, reactors up to 15 ft ID and weighing up to 230 tons, have been fully assembled and then floated by sea, river, and lake to their destination. A catalytic cracking unit regenerator of 23 ft diameter and 73 ft long was so fabricated and floated to its refinery site.

The heat exchanger division of the shop has built process exchangers of diameters ranging from 12 to 86 in., weighing up to 120,000 lb each. This type of equipment includes condensers for marine steam engines built especially for war service in Victory and Liberty ships and for various aircraft carriers.

Plate forming equipment includes rolls 20 ft long and having interchangeable top rolls for light-weight material. A 225-ton hydraulic press has a 10-ft clearance between posts and a 5 ft 'daylight' opening is capable of handling the heaviest equipment sheet that is normally used in fabricating process or other equipment. For handling other heavy plate a 30-ft long roll is provided, which can roll 4-in. plate into a cylinder 5 ft in diameter.

Additional equipment making fabrication possible to close specifications are several types of arc welding equipment including Inert Gas-Shielded and Submerged Arc units. Fourteen of the latter are provided for both automatic and semi-automatic welding.

Power and process piping fabrication is one of the most important and varied jobs for the equipment fabricator, and this shop has all equipment for bending fabrication. Power piping up to and including 30 in. diameter is filled with sand, furnace-heated to the required temperature and is pulled on bending tables, employing electric winches as power. Normally pipe bends are made up to a radius of not less than 5 nominal pipe diameters; on occasion bends down to 3-pipe diameters have been made for special purposes. Something of the time required for heavy pipe bending is indicated by the fact that 4 hours in the furnace is required to bring a 30-in. pipe filled with sand up to bending temperature.

Aerial view of the Kellogg shops. The two buildings at the right running perpendicular to the main group are the laboratories.

Congratulations . . .

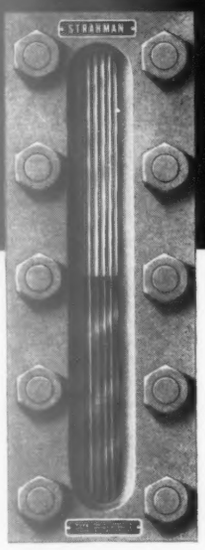
To The M. W. Kellogg Company

. . . on the completion of fifty years of industrial achievement. The Company has made many contributions to petroleum processing, and its engineering achievements have been outstanding. Through vision, ability and aggressiveness it has lifted itself into the position of leadership that it occupies today. The Company has every right to be proud of its fifty years of service.

As one of its many suppliers we are keenly interested in this Golden Anniversary celebration. We have enjoyed pleasant business relations with The M. W. Kellogg Company for many years, having furnished large quantities of pipe and fittings.

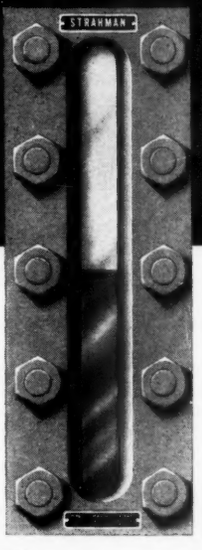
The pipe furnished by ACIPCO is made by the Mono-Cast centrifugal process in the largest individual cast iron pipe foundry in America. Being cast iron, Mono-Cast pipe enjoys an enviable reputation. Cast iron pipe has had over three hundred years of service abroad and more than one hundred years of service in the United States.

AMERICAN CAST IRON PIPE COMPANY
BIRMINGHAM 2, ALABAMA



Strahman

LIQUID LEVEL GAUGES



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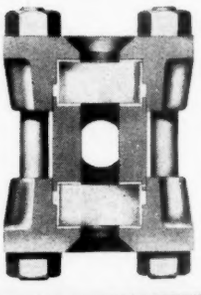

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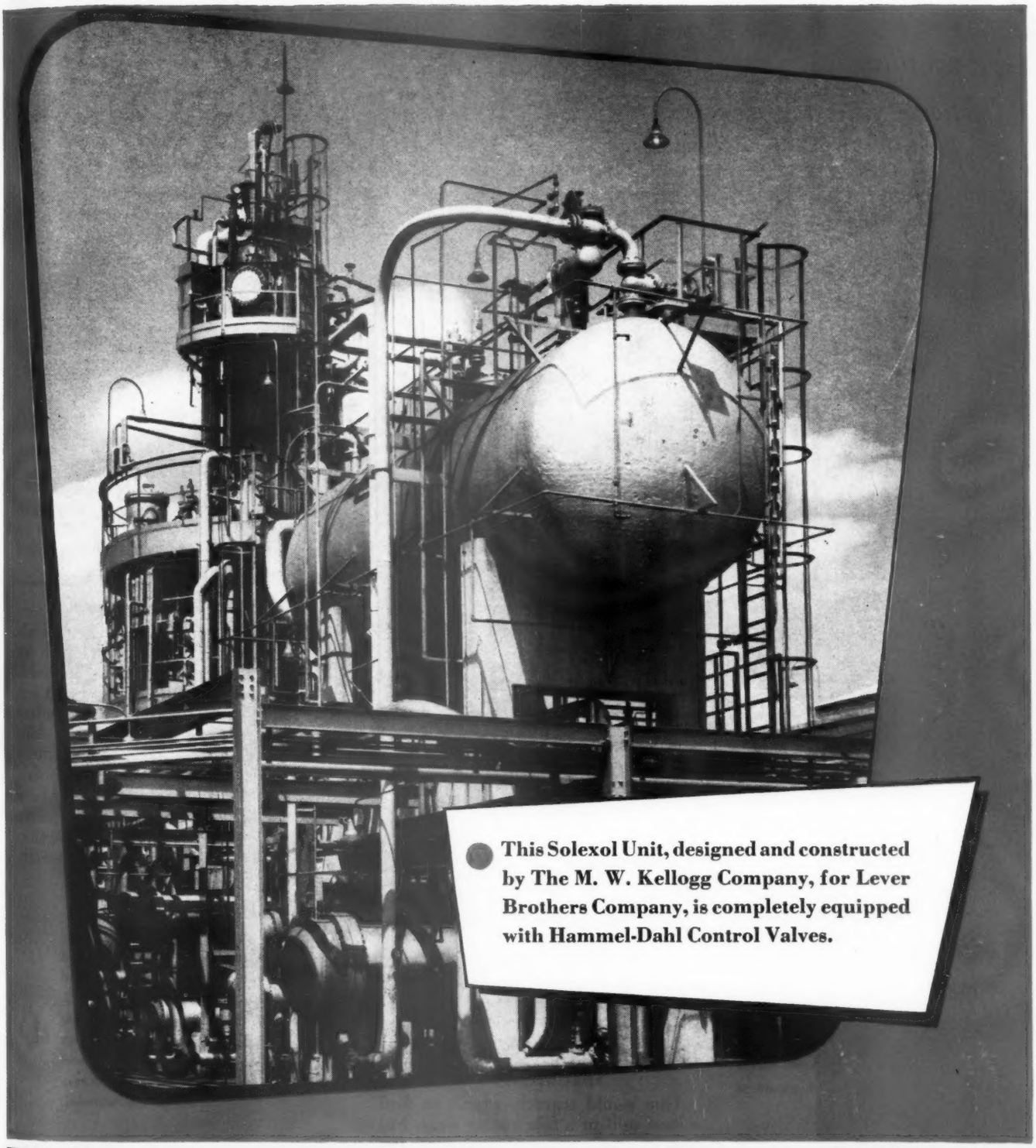

This Solexol Unit, designed and constructed by The M. W. Kellogg Company, for Lever Brothers Company, is completely equipped with Hammel-Dahl Control Valves.

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Typical of some of this power pipe fabricating is a chrome-moly steam header 20 in. diameter, made from plate rolled, submerged arc-welded, then corrugated to give greater flexibility, the final job being 20-in. diameter, 4-in. wall and 22 ft long. For steam piping on the other hand, of low chrome-moly, tubing up to nearly 3 in. wall thickness and 16 in. or more in diameter has been fabricated from forged and bored alloy billets to desired specifications.

Process piping up to 9 ft diameter has been fabricated in this shop. especially for oil refinery service. Smooth flow increment bends are made in process piping up to 60 in. diameter, of stainless steel, low-chrome alloys and clad steels, in radii from 4½ diam upward.

Piping is tested by ultra-sonic units to discover the presence of any possible imperfections, according to the most advanced test methods. Oil penetration tests are made also, to find cracks or other imperfections. Magnetic particle inspection methods are employed as well to insure properly fabricated units.

X-ray machines for inspecting steels up to 4 in. thick are provided.

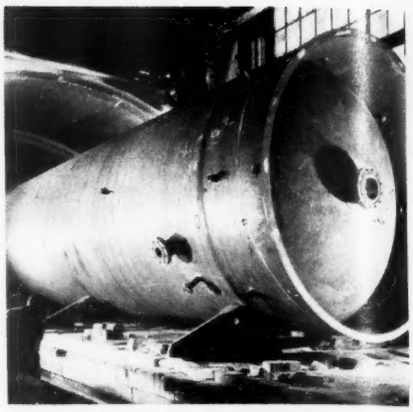
Craftsman lays out drilling points on heat exchanger tube sheet. Kellogg's heat exchanger business is a major part of the shop's activities.

Utilizing 220,000 volt, 250,000 volt, and 400,000 volt capacities these units will X-ray within the 2 per cent sensitivity that modern vessel fabricating codes demand.

Special Steels

One would scarcely expect to find a steel mill in a fabricating shop, but tucked away in one corner of the works is an electric steel mill that produces constant-analysis alloys by the so-called electric ingot process.

To describe the operation in detail would take a lengthy paper. Let it suffice that the equipment meters the required mixture of as many as 12 powdered alloying metals into a common hopper and feed line. Mixed



Typical of the huge vessels that may be stress relieved in Kellogg's furnaces is this fractionating tower for high pressure service.

powders are fed automatically into a mold where they are melted instantaneously and continuously until the ingot is formed.

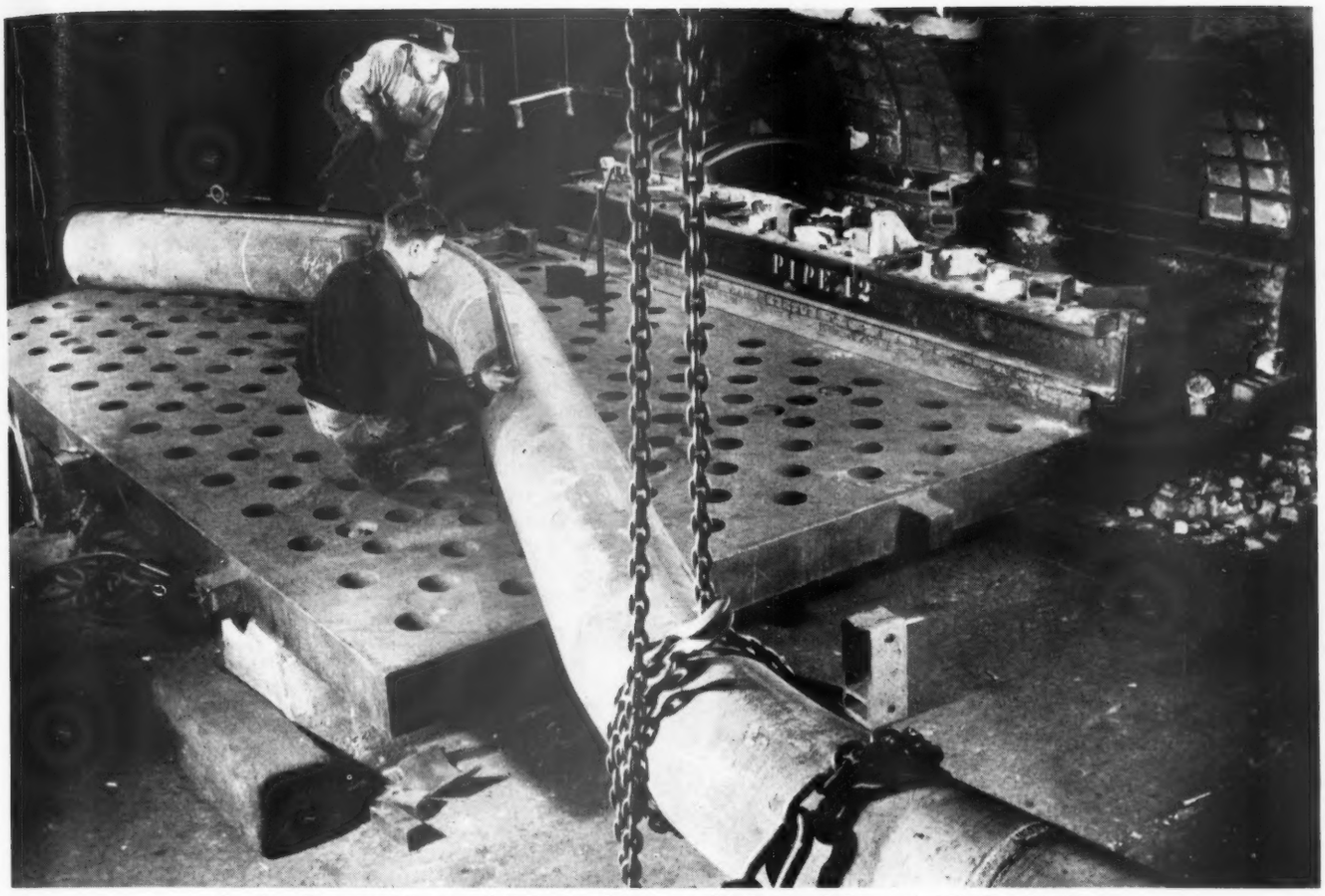
Because of their qualities, the ingots are now being used extensively in the manufacture of turbine wheels for jet engines. Test after test has shown these wheels to be superior to those made from materials used previously. In fact, even the most drastic tests at excessive rpm's have failed to fracture them.

Chemical Manufacturing

Outstanding among the chemicals and similar products developed by the Kellogg organization is undoubtedly the manufacture of Kel-F, an important plastic derived from hydrocarbons in which fluorine and chlorine have been 'inserted.' Originally the work that developed into this chemical plant operated at Jersey City was begun by Professor W. T. Miller of Cornell University, in connection with special oils and other materials

Top right—before any heavy welded pipe is bent it is first filled with sand to ensure regularity of the bend. The piping is then heated to the proper bending temperature, an operation which may take several hours depending upon the thickness of the material.

Right—Huge diameter process piping, such as used in fluid catalyst carrier lines, is bent in one piece on this exclusive Kellogg machine. It is designed to take piping up to nine feet in diameter, and produce bends of even contour and smoothness which markedly reduce the effects of erosion.



Shaping of power piping on a bending bench is done with electric winch operated block and tackle.

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needed for Oak Ridge during the War.

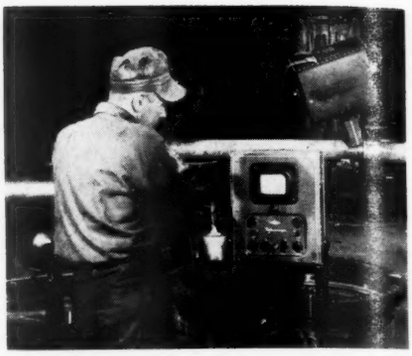
The first commercial production of Kel-F was about December, 1947, and since that time a great many applications for the material have been developed; three price reductions have been made as production-consumption increased. Many more new applications are in the offing and under careful study. This product is extremely inert chemically, is a true thermoplastic, and can be molded by all conventional methods and extruded. It has the property of not retaining water, etc., on its surface, can be applied in dispersion form to surfaces as a coating. The non-wetability property enables the makers of electronic equipment to use it extensively, and one of our largest electrical manufacturers employed it to solve a 10-year research problem of hermetically sealing terminals. It is used widely for military electric and electronic equipment.

As a corrosion resistant material it is useful for gaskets. Where corrosive conditions have forced diphragm or gasket changes each 24 hours, it has given up to 9 months' service. It is completely resistant to all concentrations of nitric, hydrochloric, and sulfuric acids and other corrosives. Its non-sticking properties make it useful for example, as a surface covering for bakery work where dough may touch the surface; savings in flour are

Typical of the products made by moulders from Kel-F is this valve diaphragm for use in corrosive services where other materials would rapidly fail.

an important advantage. It may be employed wherever temperatures do not rise above about 390 F.

Other products manufactured here on commercial scale include the pyrophosphate catalyst for the olefin polymerization process developed during the mid-1930's. The special Hydroforming catalyst was developed and is still being made here, having recently been improved. During the last War a catalyst for use in the Fluid



Ultrasonic testing of piping permits relatively inexpensive inspection that could never be afforded with radiographic equipment.

catalytic cracking process was developed and manufactured to aid in meeting the emergency demand. Research on catalysts, as indicated earlier herein, goes on continuously, ranging all the way from test-tube size to large-scale commercial operations.

Special Products, Fuels Research

Little may be said here about the extensive research being carried on on jet fuels, rocket fuels, jet and rocket engines, and analogous projects, all of which are government contract research and the information thereon highly restricted. This general field constitutes an important division of the Jersey City establishment, set off to itself and guarded as closely as any military development may be.

Actually, it is necessary to see at first hand the huge number of projects, researches, fabrications, and other activities of the Jersey City organization to appreciate the ramifications of the interests of the old-new "outfit." It is of the "warp and woof" of such work by a great many agencies that the industrial, commercial, military, and social welfare of a nation is made.

Photomicroscopy plays a vital part in metallurgical studies. Kellogg technician here adjusts instrument before photographing sample.

Extensive metallurgical studies natura'l/ play an important part in any fabricating operation. Here a Kellogg metallurgist studies a metal sample during creep tests. The company maintains one of the most complete creep laboratories in the nation.

LARGEST

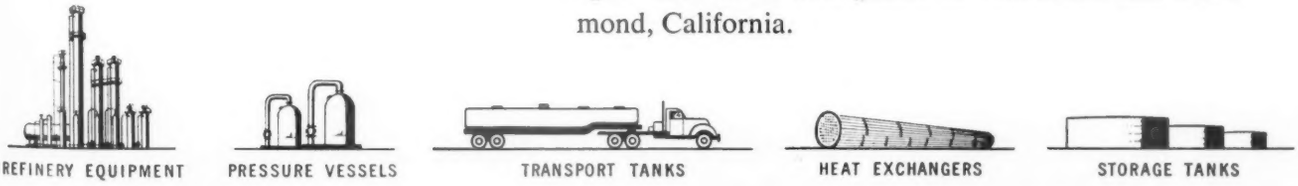
VACUUM COLUMN

IN U. S. A.

Fabricated and erected by Southwest

This Vacuum Column, field erected by Southwest through the M. W. Kellogg Company for a major oil company in California, is 27 feet in diameter by 84'-6" overall high, weighing approximately 760,000 pounds. It is partially alloy lined and contains alloy and carbon steel trays.

For complete manufacturing service, including engineering, fabrication, and field erection, depend upon Southwest with plants in Alhambra and Richmond, California.



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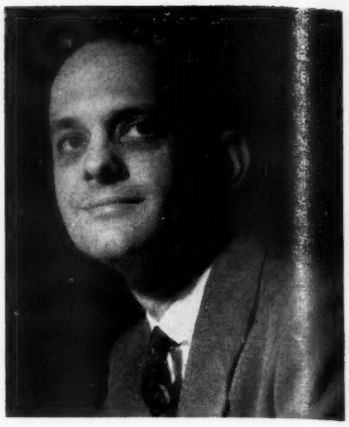


THE EDITORS SCAN A PIECE OF THE FUTURE

AFTER an intensive briefing of the research program in the director's office and a detailed review of the organization chart, we began a whirlwind tour of the two good-sized, converted mill buildings that comprise the Kellogg petroleum and chemical research laboratories in Jersey City. Now glass - bricked and air - conditioned, with their towering roofs breached in spots by the tops of pilot plant towers, these two buildings to a large extent contain the promise of Kellogg's future . . . and also much of the data-producing facilities utilized in securing present day chemical processing business.

The array of scientific instruments, of talent, and of special Kellogg-created equipment was impressive but the thing that really struck us a bit was the fact that here within not more than 25,000 sq ft we reviewed one of the most modern, most complete oil refineries to be found . . . with a few major chemical plants thrown in. Here were units to produce alkylate, cumene, diesel oil, polymer gasoline, lube oils, LPG, finished avgas and motor gasoline, hydroformate, purified ethylene ready for chemical manufacture, and even synthetic crude.

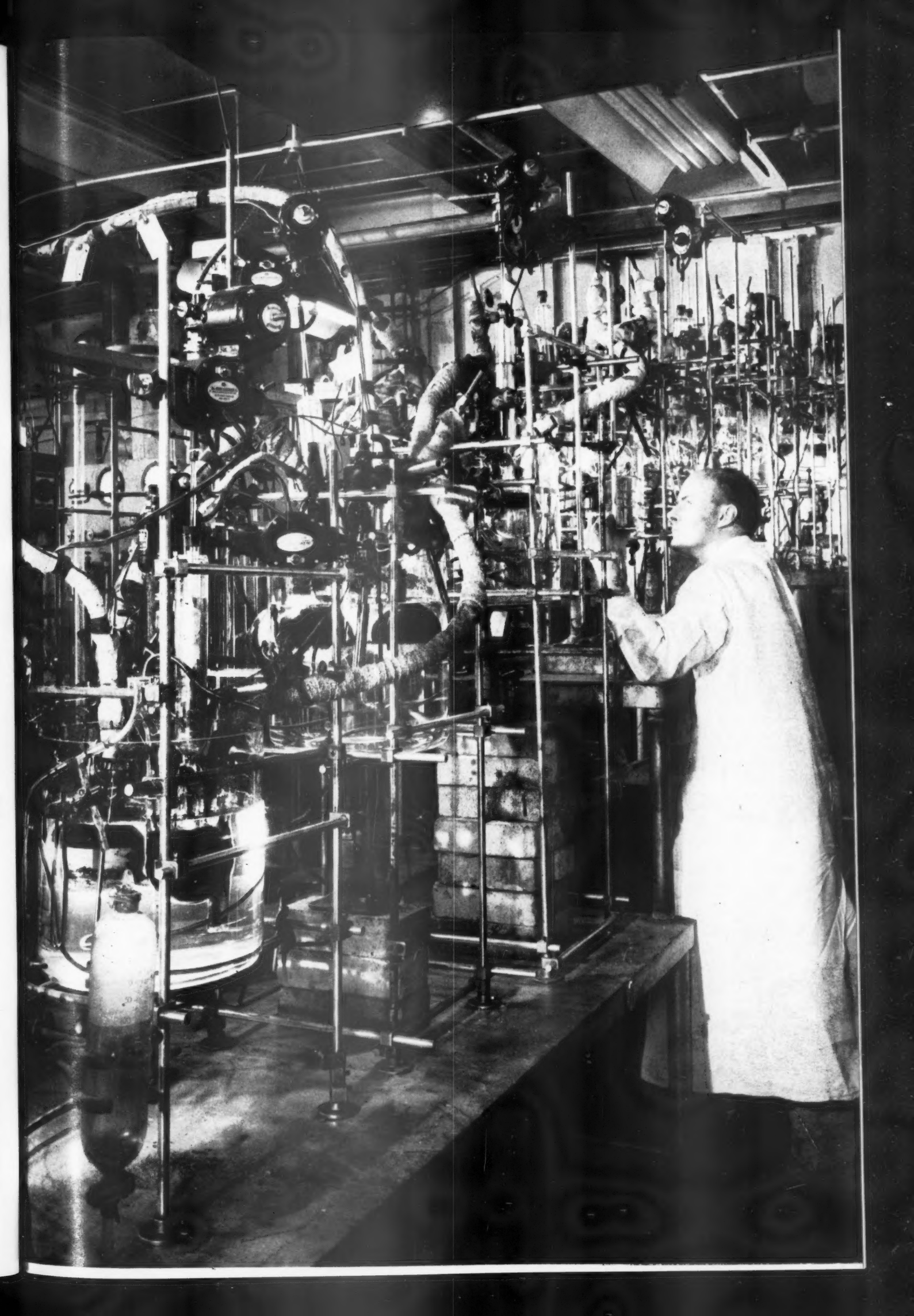
Obviously, in the opinion of many leading researchers, the process chemical reactions are the fundamental items in the field of industrial development. Therefore, the "Hub" of Kellogg's research is the Organic Chemistry and Physical Chemistry Divisions. The Organic Group, headed by six Ph. D.'s, is itself divided into three sub-divisions—Research, Application, and Information. The research staff carries on "exploratory research" in the field of organic chemistry, looking to discover and develop new processes and thus new products. The effect of pressures on organic reactions, from atmospheric to 35,000 psig, is under continuous study, along with fundamental research in hydrocarbon, halogeno - hydrocarbon products, synthesizing monomers containing especially fluorine. Studies on polymerization of these compounds are carried out.

Clearly, if the Organic Research group's work is to have industrial fruition, it must be applied to practical uses, and this application is the job of the closely affiliated Applications Group. One of the main jobs of this group is that of serving as liaison between laboratory, patent, production, and sales divisions for the company's commercial products.

The Physical Chemical Group is similar in function to the Organic Group, and carries on "exploratory research" in the petroleum field. New catalysts and new methods of processing petroleum fractions are investigated. Physical chemists, inorganic chemists, and chemical engineers comprise the technical staff in this group.

Then, to follow on after this point; the Chemical - Engineering — Pilot Plant Operation Division includes a group of chemical engineers entirely

Detailed studies of solvent extraction processes are carried out in this brand new, multi-stage mixer settler apparatus. The unit consists of 10 stages, each immersed in an oil bath for individual control. Solvent and feed can be introduced to any stage and product solutions withdrawn from the end stages. Stream samples can be withdrawn between stages to provide data for calculation of equilibrium curves and stage efficiencies.



separate from the engineering staff in New York, and, all-important, 17 experienced pilot plant operators. All of the last-named have spent many years in pilot plant operation, know the requirements for this type of work, know how imperative it is that all operators be reponsible for all work intrusted to them, and, therefore, are trustworthy to the last degree in their chosen fields. The overall group is charged with design of processes based on findings, and with the pilot plant investigation of all processes that are to be studied in the pilot plant phase of development. A score of pilot plant installations have been made in the laboratory, which units cover practically all the types of process operations that the laboratory may be called on to study. This 10-bbl per day unit may be and has been used to study the distillation range characteristics of all types of petroleum from the crude itself to the close fractionation of naphthas into very narrow boiling cuts for the study of Hydroforming operations thereon. In addition a 2-bbl per day continuous vacuum still is on hand in which, especially, high-boiling petroleum fractions may be subdivided for any given purpose.

Another pilot plant method utilized for the fractionation of high-boiling fractions of petroleum is with liquid propane as solvent. The pilot plant is built around two 40 ft long countercurrent towers that may be operated in series, in parallel, or one at a time as conditions may require. Feed pumps for solvent (propane) and oil charge are included, also coolers and pressure storage for the propane. This unit will circulate as much as 30 bbl per day of solvent and will treat from 1 to 8 bbl of oil per day. By countercurrent flow the lighter, lower molecular weight hydrocarbons are dissolved and removed from the heavier residual or asphaltic components.

Tower temperatures are controlled by electric jacket heating elements as well as by the temperature of the incoming streams to achieve the desired results and to study the effect of temperature variations on the process.

Companion piece to the propane unit is the phenol solvent extraction unit, in which up to ¾ bbl per day of oil may be treated. The main tower is 18-ft long, packed with stainless Raschig rings. The solvent, phenol, is preheated and pumped to tower top, descends through the tower, taking up the more cylic constituents in the raw charge and allowing the more paraffinic components to pass upward and out at the top.

Another system for studying extraction processes is the multi-stage. mixer-settler assembly in which are provided ten stages; each mixer-settler is surrounded by a separate oil bath for individual temperature control. Two half-liter spherical vessels constitute each stage, one for mixing solvent and oil, the other for settling and separation.

Fluid Catalytic Cracking Facilities

To continue careful research in Fluid catalytic cracking a 4-bbl per day complete unit is installed and has been operated for several years. The unit is equipped with pumps, controllers for catalyst flow and levels; catalyst can be circulated at rates from 50 to 700 lb per hour. In addition to the reactor and regenerator, a complete set of auxiliaries is provided including liquid pumps, liquid-gas separators, reflux drums, compressors, catalyst level and flow controlling equipment, temperature and pressure indicating and recording instruments, fractionator and stabilizer towers, and all the other units required to simulate exactly the operation of a large-scale fluid cat cracker. The reactor is a 30-ft stainless steel tube equipped with porous ceramic filter elements for removing catalyst from the vapor stream, instead of the typical cyclones used in large plants. The regenerator is 19 ft long, and is designed similarly to the reactor. Traces of vapors are stripped from the catalyst in a bottom stripper section, using steam. Reactor exit vapors are fractionated in a 16-ft tower and the overhead stream is stabilized in a 13½-ft tower, packed with Raschig-rings.

Hydroforming Unit

One of the outstandingly unusual processes used by the refining industry is that of Hydroforming, developed before the Second World War largely in this laboratory, and a discussion of the process details are given elsewhere in this issue. The pilot plant in the laboratory is of 3-bbl per day capacity operating on the fluid catalyst principle, is made up of catalyst storage hopper, regenerator and reactor, along with two compressors, liquid-gas separators and all the necessary control, recording and indicating instruments.

The Fluid principle of stock-catalyst contact is employed also in a catalytic desulfurization pilot unit that also includes reactor, regenerator, scrubber, separating drums, compressors, instruments, etc. Reactor and regenerator are 44-ft long—same size as the Hydroformer units — topped by a section filled with stainless steel porous filters for catalyst interception. Unit has a two-bbl per day capacity.

Synthesis of Hydrocarbons

Another significant section of the laboratory is the two Synthol units, the small 0.3 bbl per day "test-tube" unit on which the earlier work on the so-called Fischer-Tropsch synthetic hydrocarbon reaction was carried out; and the large, 5 bbl per day unit which has provided the data from which commercial Synthol units are being designed. One such unit now under design for a South African syndicate, will make gasoline diesel fuel commercially from coal.

Synthetic petroleum production is a subject so all-wide that the only points of interest are the controlling conditions that affect the final result, the ultimate production of whatever yields may be had from the system.

"Way back when", the Germans, short on petroleum and long on petroleum technology, began, through the activity and 'brains' of Franz Fischer and Hans Tropsch, to synthesize petroleum-like hydrocarbons from coal, peat, lignite, and other non-petrolic hydrocarbons. From lignite coal these researchers produced hydrocarbons, from methane to kerosine, lubricants, waxes of extremely high molecular weight, and asphalts, but failed signally to produce synthetic hydrocarbon fuels that could compete with petroleum derived fuels.

In this country, after World War

Every pilot plant requires mechanical engineering. This photograph shows a portion of the design section, made up of engineers who are particularly skilled in pilot plant design.

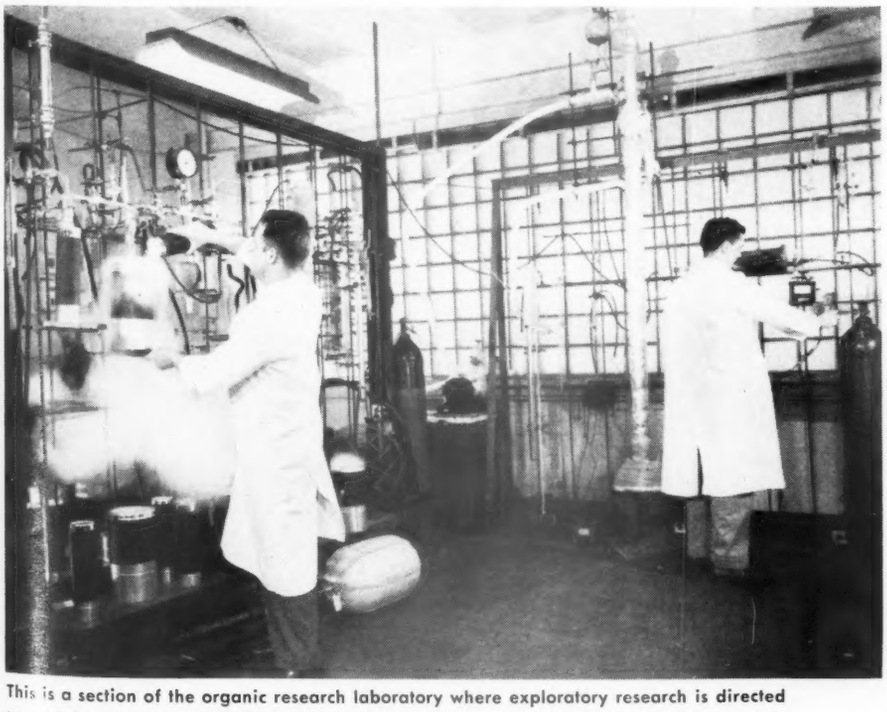
II, strenuous efforts have been made to perfect this synthesis, and with very far-reaching results. Petroleum - like hydrocarbons have been synthesized in quantity at much improved economic levels. South Africa, among others, is taking advantage of the practicability of hydrocarbon synthesis, beginning with locally plentiful cheap coal deposits.

Probably the greatest single factor in the solution of the synthesis problem, and the technical desirability of Kellogg's Synthol Process, is the use of the fluid catalyst principle, already proved in catalytic cracking. Heat removal from the reaction zone was the bug-bear of the German technologists; in this country it proved that the simplest method of doing this is by taking the heat, bodily, out of the zone in the form of hot catalyst. Therefore, the at best partially successful synthesis in Germany has become the (technically) eminently successful American system. Obviously the synthesis reaction is highly exothermic, which makes the Fluid catalyst principle just about mandatory for any success, either technical or ecnomic.

Out of the reactor a galaxy of products comes; hydrocarbons through the diesel oil range; aldehydes, alcohols, acids so great in numbers and so dilute in concentration that the mere concentration - isolation problem is one of the major jobs of the chemical industry. And, for a plant of 7000 bbl per day of motor fuel, the quantity of these chemicals produced per annum is positively phenomenal, going into the hundreds of thousands of barrels, and we know not yet how much more. It is technically possible, of course, to de-oxygenate these chemicals and so yield more hydrocarbons, a solution of the problem planned for the South African plant that is being designed to produce maximum yields of gasoline and diesel fuels.

Pyrolysis of naphthas and other "heavy" stocks to produce large yields of ethylene, propylene, and other light olefins is an important step in the fast growing worldwide petro-chemical industry which is undertaking to synthesize innumerable chemical and industrial products. With a 2-bbl per day pilot unit, Kellogg's laboratory can reproduce any type of pyrolysis operation desired. Among other interesting pilot operations is that of naphthalene oxidation, wherein molten $C_{10}H_8$ is mixed with preheated air and conducted through a Fluid catalyst bed, coming out as phthalic anhydride.

Long ago researchers found out that the only method by which results can be attained in the laboratory is to design the equipment properly for the results wanted or hoped for. To accomplish this the laboratory engineering division includes four sections; design, machine and instrument, glassblowing, and mechanical. Design utilizes continuously the services of a special group of engineers and plans all laboratory and pilot plant units; The Mechanical Section has a score or more who do nothing but build the units developed by the design section. Four instrument men comprise the M. & I. Section, while a team of glass blowers are kept busy day after day making the special equipment needed.



This is a section of the organic research laboratory where exploratory research is directed toward the discovery and developments of new organic products and processes.

Commemorative Section of The Petroleum Engineer

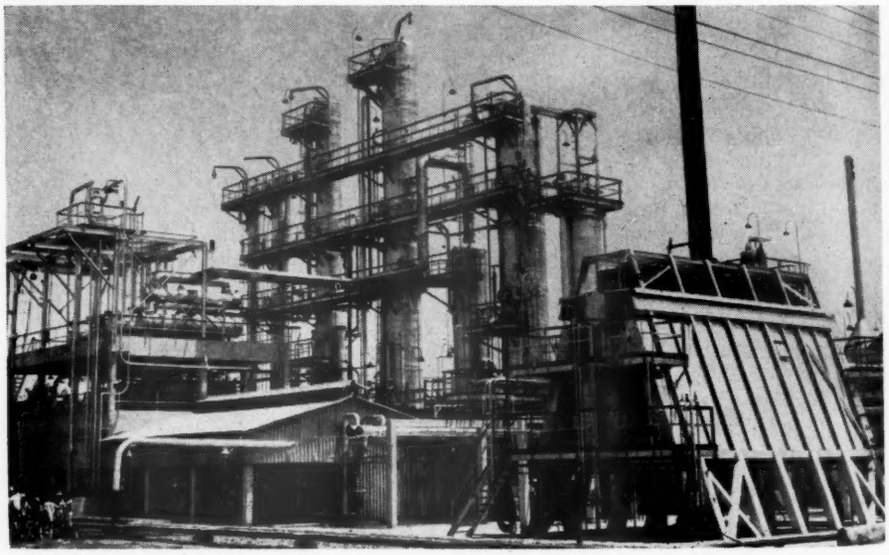
Research, Processing, Engineering Take Shape on Construction Lot

As THIS ISSUE GOES TO PRESS, Kellogg engineers and technicians are directing major refinery and chemical plant erection on more than a score of construction lots scattered all over the world. In addition, Kellogg utility power piping installation crews are working on as many more major projects within their own industry, installing the main steam piping for more than 2,500,000 additional kilowatts of electrical generating capacity.

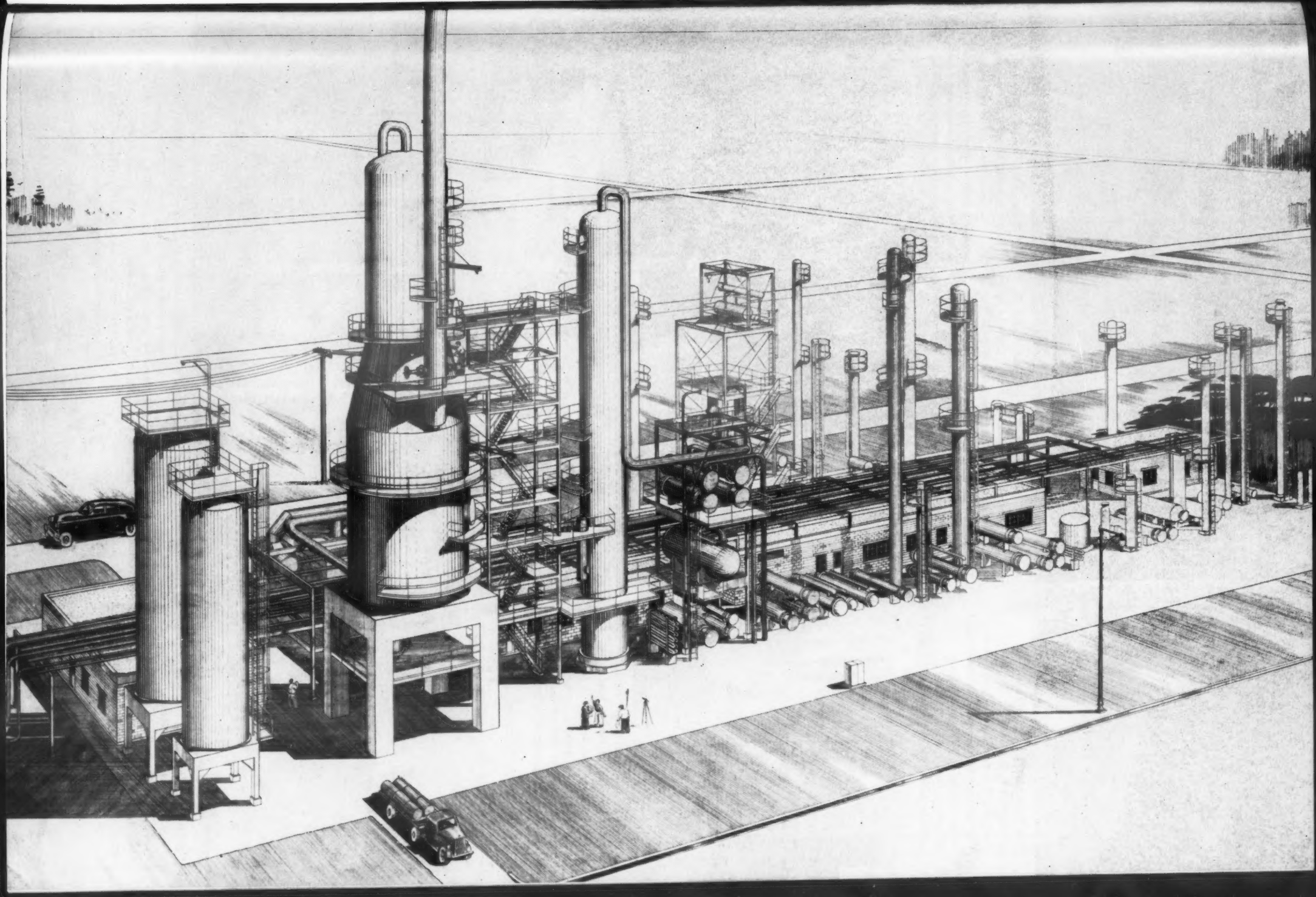
Shown on this and succeeding pages are recent "progress photos" from many of the Kellogg refinery and chemical projects underway, or currently being put on stream. The very magnitude of the composite construction lot picture speaks eloquently for the value of Kellogg's basic service premise of integrated research, processing and engineering.

Right—Canadian Oil Refineries' new $18,000,000 refinery near Sarnia, Ontario, will be the second in Canada to incorporate the Orthoflow Fluid catalytic cracker design. Kellogg's portion of the complete refinery includes the units illustrated in the drawing.

Below—This year saw Brazil's first modern combination refinery go on stream situated at Mataripe. Unit processes include crude distillation vis-breaking, thermal cracking, thermal reforming and stabilization as well as product treating. A duplicate combination grouping of basic process equipment is now under construction at the same site, to double the refinery's capacity and a 10,000 BPD unit is planned for Rio de Janeiro.

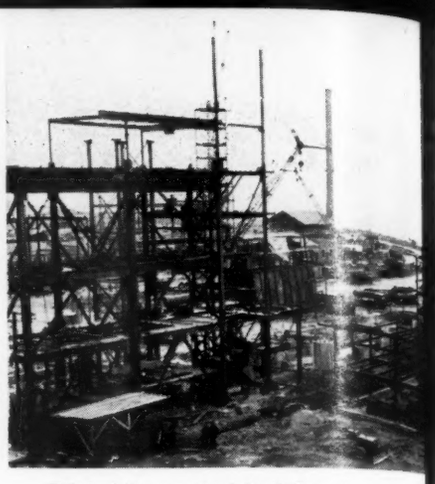


Below—At Port Arthur, Texas, the Fluid catalytic cracker with the world's largest throughput (60,000 BPD) is taking shape in Gulf's huge refinery.



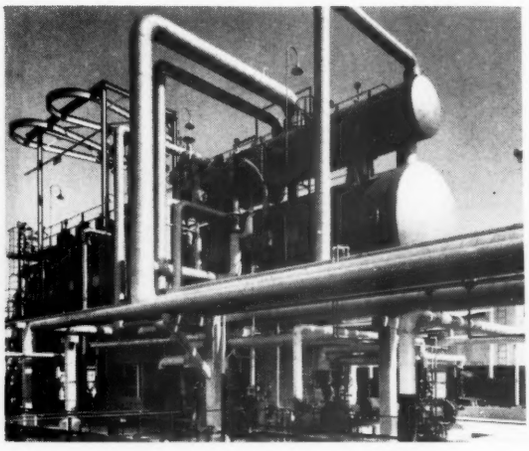
This 10,000 BPD Fluid cat for AIOC at Grangemouth, Scotland, will soon be complete. Guy derricks speed the vessels to their proper locations. Additional equipment being installed by Kellogg includes a phosphoric treater, a 17,500 BPD vacuum unit, and a catalytic polymerization plant.

Another AIOC job is just getting well started at Kent, England, where a Fluid catalytic cracker and gas recovery unit are scheduled for completion in 1952. Just in front of the crawler cranes may be seen the piles driven to support major structures beyond which are tool sheds and pipe fabricating buildings where much of the process equipment will be made.



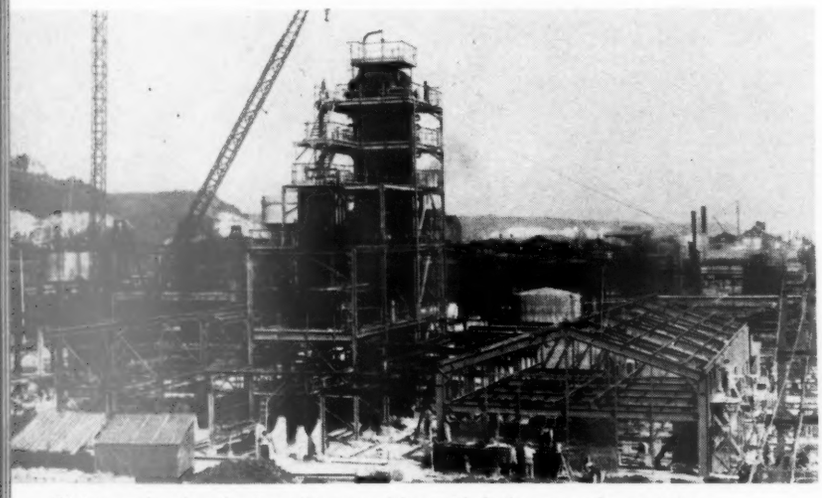
Third of three major jobs Kellogg is currently doing for AIOC in the United Kingdom is this Fluid unit and gas recovery plant at Llandarcy, Wales. Steel work is well underway and a good percentage of the heat exchangers have already been installed.

The first U. S. Orthoflow Fluid catalytic cracker is going up here at Ponca City, Oklahoma, for Cities Service. In center is the concrete, pedestal base for the combined reactor-regenerator vessel. When complete, this cracker will process 8300 BPD.

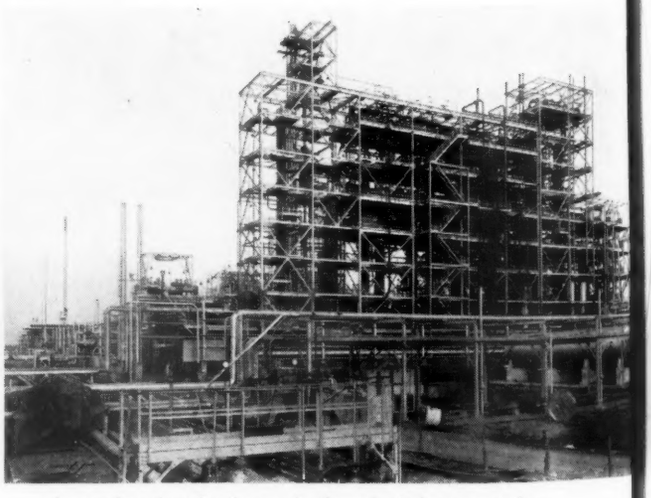


Much of the success of alkylation as a process is due to the design of the reactor. This Kellogg-designed reactor has cascade flow, motor driven agitators, auto-refrigeration and moderate isobutane recycle. Two units have gone on stream this year: One at California Refining's Perth Amboy plant and one at West Tulsa for Mid-Continent Petroleum. Two others are being engineered for Standard Texas and Continental.

In Dunkerque, France, Kellogg International Corporation is erecting important units for Societe Generale des Huiles de Petrole. These include thermal reforming and cracking facilities.



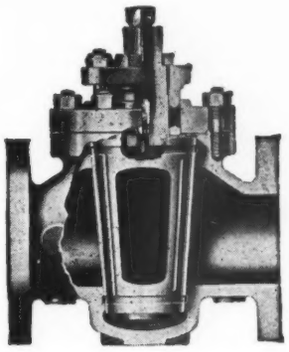
Eight months after the first piles were driven, this is the approximate status of a propane deasphalter Kellogg processed and engineered for Compagnie Francaise de Raffinage in Gonfreville, France. In addition to this unit, Kellogg is also supervising the installation of a furfural extraction unit and is directing the revamp of thermal cracking and reforming facilities.



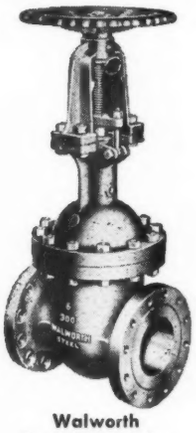
A complex plant for the production of ethylene, propylene, and other petrochemical charge stocks is expected to be producing this summer. Situated at Wilton, England, this olefin cracking unit is the first of its kind in England or the Continent. Contracts for a second one have just recently been signed between the Montecatini Company of Italy and Kellogg.

● VALVES

● PIPE FITTINGS



Walworth
Lubricated Plug Valve



Walworth
Steel Gate Valve

Walworth
Iron Body Gate Valve

Walworth
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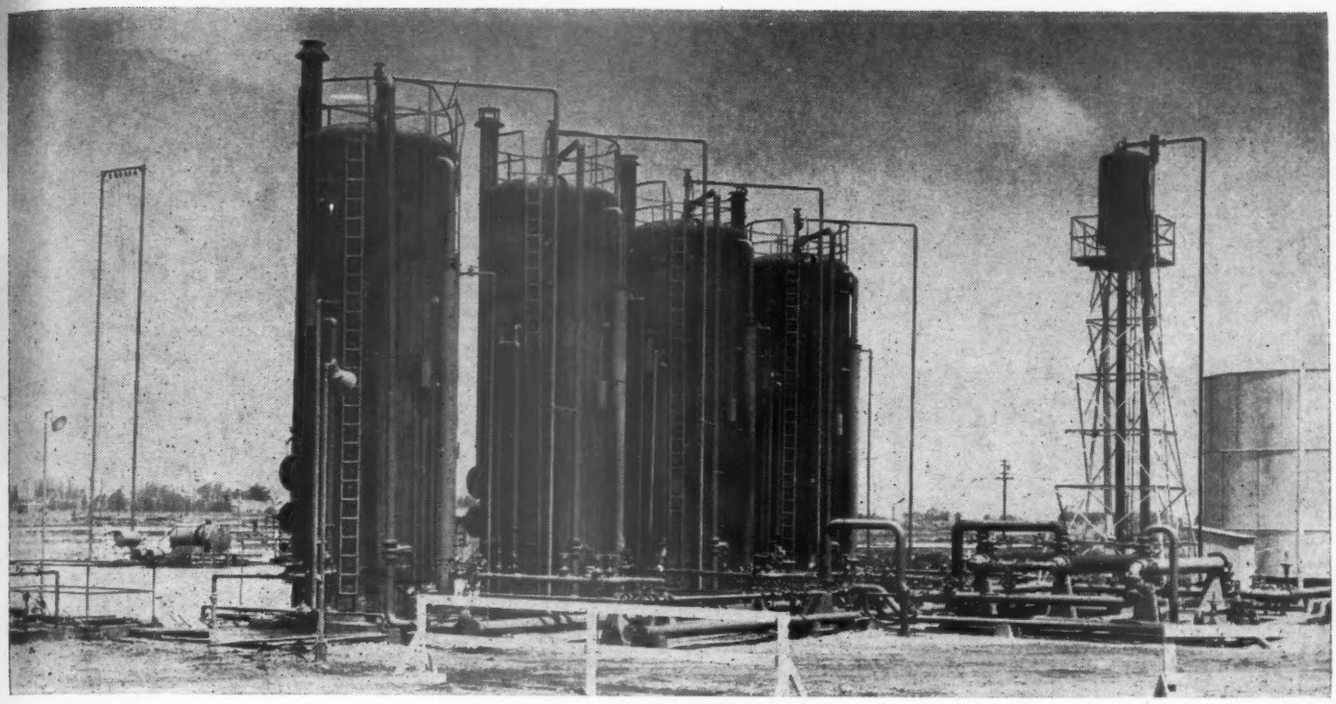
DISTRIBUTORS IN PRINCIPAL CENTERS THROUGHOUT THE WORLD

Research is the key that has unlocked nature's secrets throughout history. The fascinating Kellogg story told in preceding pages is an example of how one leading company has, through development of processes and equipment, supplied the world with new and improved petroleum products. Research and development work of the kind in which Kellogg has played so prominent a part is the key to future progress.

The Editors



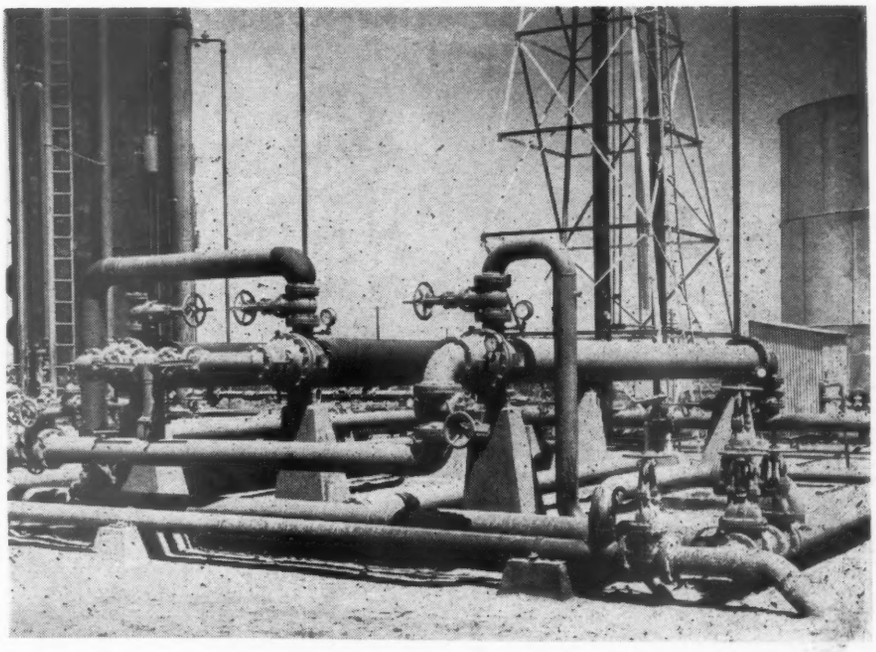
Battery of four vertical emulsion treaters at Signal Oil and Gas Company's Bolsa treating plant.

Signal Treats Hydraulic Oil

Simple heating-settling system "cleans up" emulsion to yield pipe line oil in California Coastal field.

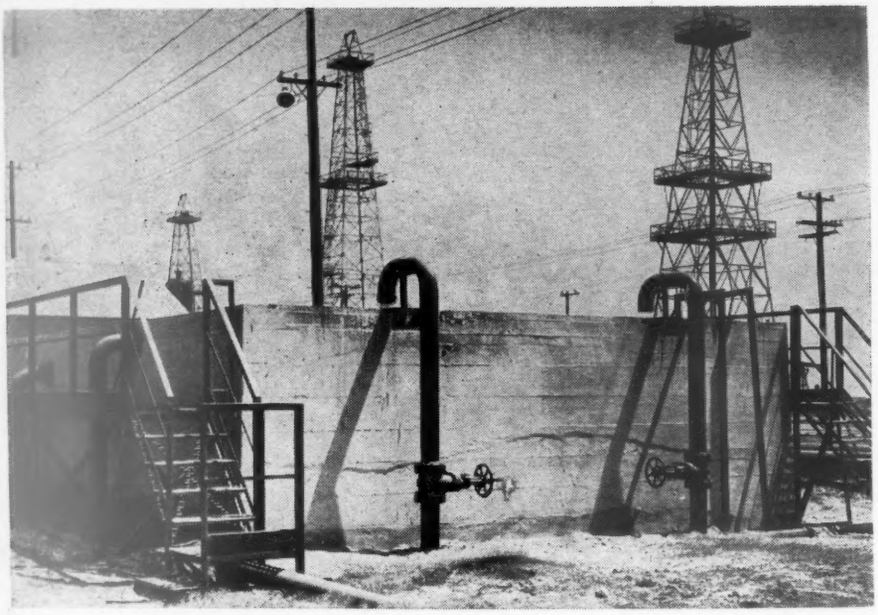
J. C. ALBRIGHT

NORTHWEST of and adjacent to the fabulous Huntington Beach, California oil field is an area bordering on U. S. Highway 101 that has lain idle for many years after 'Black Gold' was discovered on the Palisades along the Pacific Ocean. The area is a low, flat marsh-land criss-crossed by rivulets and drainage ditches, separating hummocks and long fingers of drier land where the only vegetation is peat moss and tule or the great bulrush. Practically the entire area can be flooded with fresh water in the rainy season by closing locks on the only outlet from the marsh to the sea. By impounding fresh water to fill the rivulets and drainage canals, surplus is allowed to soak into the subsurface to be recovered again in the dry season with pumps, to irrigate and supply operating water for the leases. When the land is flooded with fresh water, water fowl find it



Three horizontal shell and tube exchangers. Two on left handle oil to and from heaters; one on right acts as jacket water cooler.

EXCLUSIVE



Concrete water pits where final skimming of residual oil is accomplished.

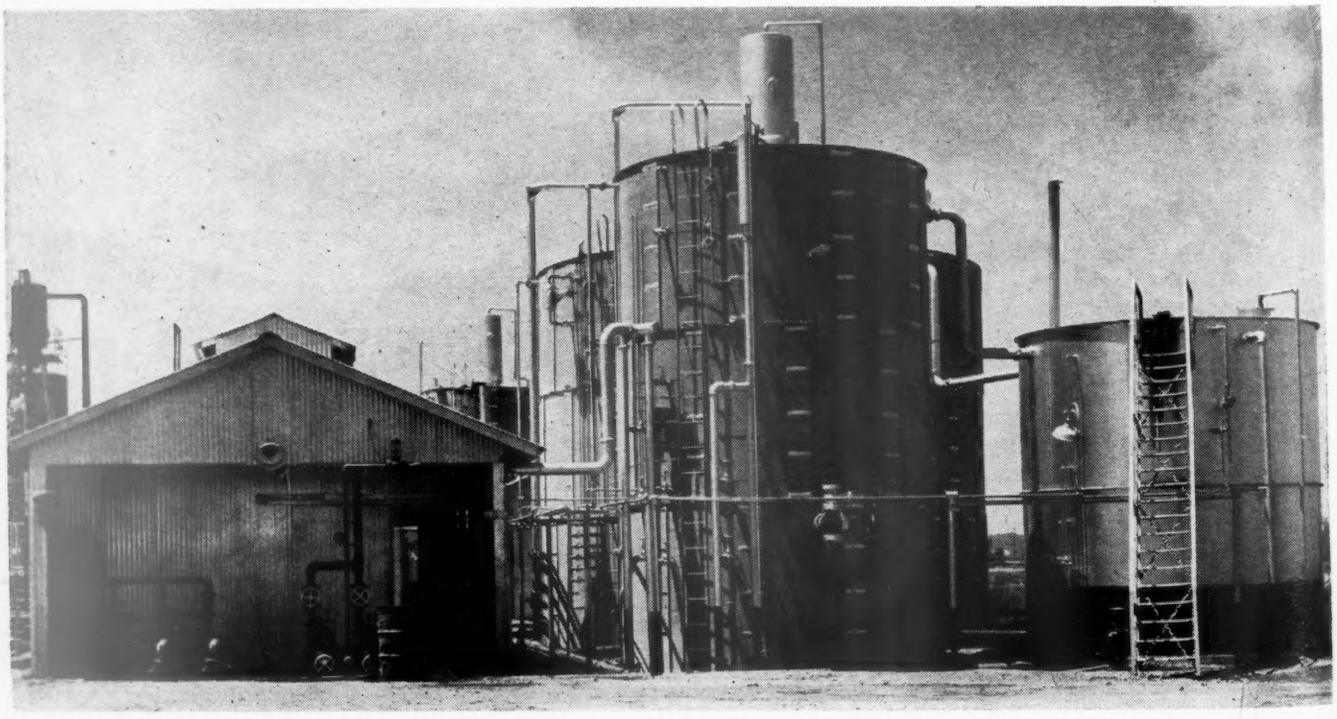
an ideal play-ground, and the area can easily be converted into a duck hunters paradise.

Signal Oil and Gas Company, of Los Angeles, made a deal with the fee owners about 10 years ago to secure mineral rights for oil and gas exploration. Production of oil was obtained in several separate formations ranging downward from 3600 ft. Orderly drilling and conservative production methods have resulted in maintaining the reservoir pressure to a marked degree so that a number of the 140-odd wells continue to flow the allowable quantity of oil. Due to cross-faulting, some of the wells are completed in less favorable oil traps and are produced with conventional gas engine driven jacks, or by the use of subsurface hydraulic pumps. As in most California Coastal fields, the oil is cut with a varying degree of emulsion, ranging from clean, acceptable pipe line oil to a cut of several per cent. Production from that section of the lease where wells are pumping large volumes of connate water, is transferred separately into special tankage where an element of time is provided to permit free water to be disengaged and settle out without assistance. None of the emulsions are of a type that are considered to be extremely 'tight', but chemicals are employed to accelerate the breaking out of the oil.

Two processes are operated in the central battery of the Bolsa lease to treat oil containing water and emulsions. Oil that is to be used for operating the subsurface hydraulic pumps is treated in vertical emulsion treaters so that the oil can be cleaned to an average of 1/10th of 1 per cent. Oil that can be prepared for the pipe line with more or less conventional methods is transferred from the field directly to, or from primary water separating tanks to wash tanks and heaters where chemicals are introduced to prepare the material as acceptable pipe line oil.

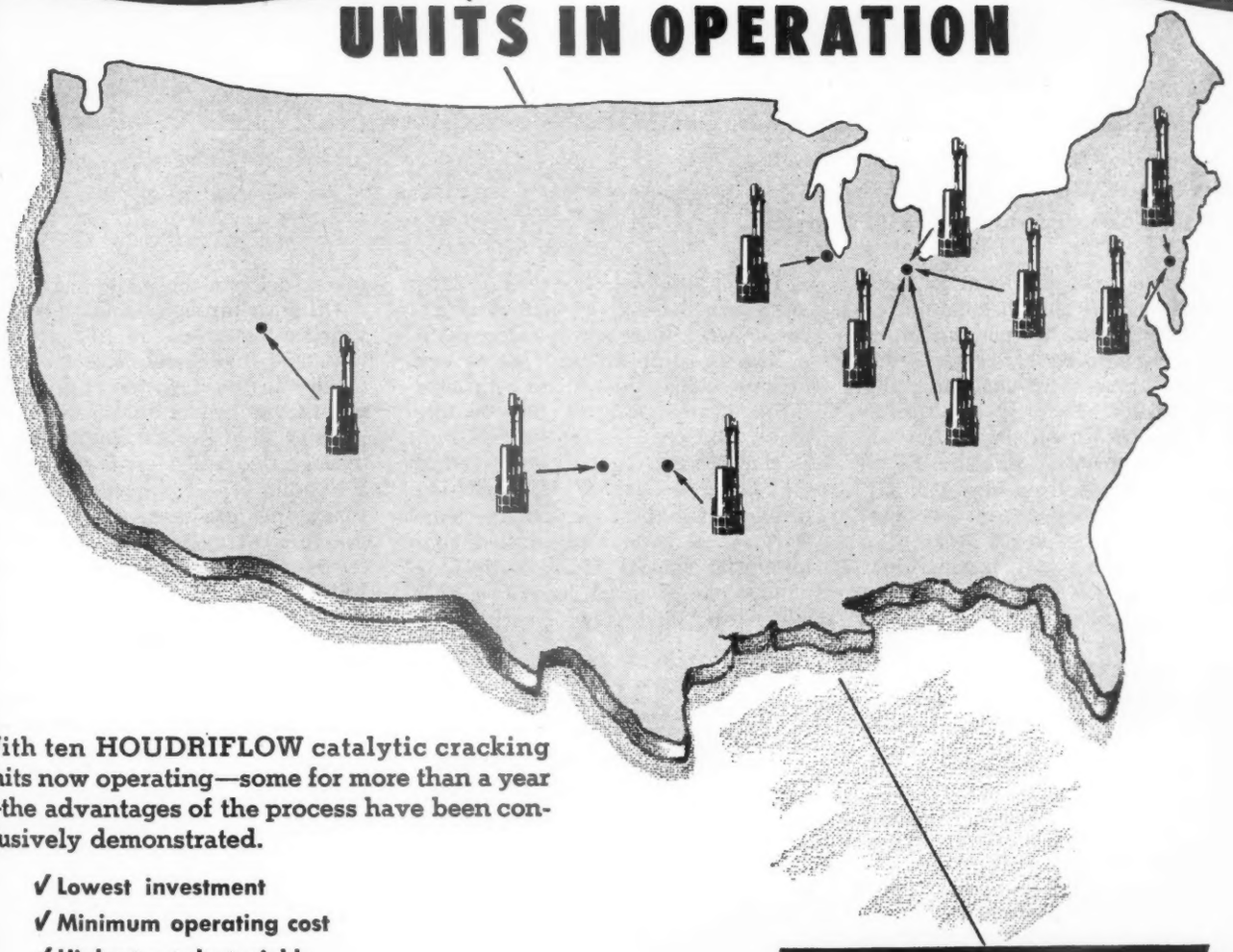
The emulsion treaters are units 6 ft 8 in. by 27 ft 6 in. vessels designed with internal equipment to secure the maximum utilization of applied heat so that practically a complete separation between water and emulsion and the oil is obtained. These units have a design capacity of 2000 bbl each, and the battery contains 4 such emulsion treaters. These units are operated in parallel and each is handling approximately 2250 bbl daily. Integral heat exchangers designed for the units are effective for normal operation. If a greater quantity of oil is to be treated, either the fuel should

Receiving tanks at pump house, which contain oil at 160 F to be returned to subsurface hydraulic pumps.



10 HOUDRIFLOW

UNITS IN OPERATION



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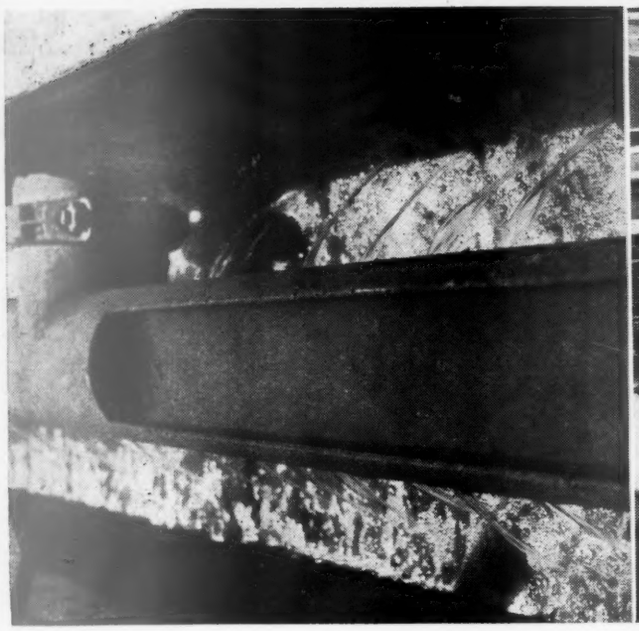


Split pipe line with numerous small holes to assist in breaking out small globules of oil from water prior to delivery to disposal.

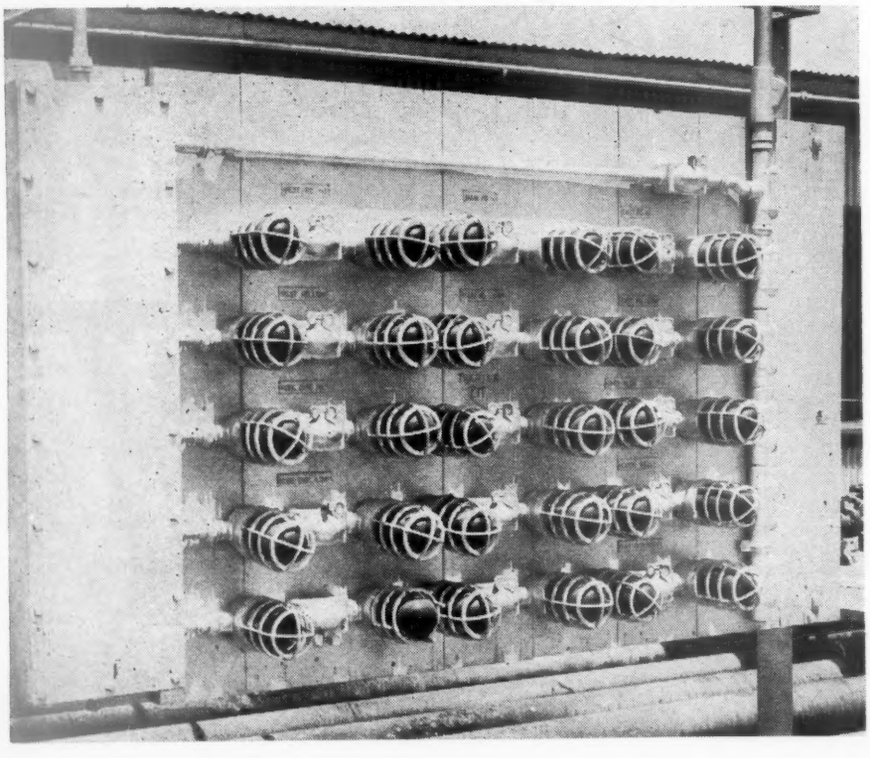
Split pipe line, which is set perfectly level so oil floating on surface will be removed to sump.

be increased, or additional exchangers included in the installation. So that conservation of fuel can be effected, the treating battery is equipped with three extra shell and tube interchangers. Two of these units are operated directly with hot oil, out of the treaters against cold oil freshly produced from the field. The third unit is used to recover heat in the gas engine jacket water by a counter flow of the jacket water against the fresh oil from the field delivery pipe lines.

The approximately 9000 bbl daily are received from the field in different delivery lines which converge in a header equipped with gates and fittings so that the oil can be routed through any path in the treating plant. The principal route, however, is that leading to the four vertical emulsion treaters. After passing through the heat exchangers, the warmed oil enters a manifold containing a special fitting with four outlets, one of which leads to a specific treater, and likewise, each of the others delivers the oil to the others.

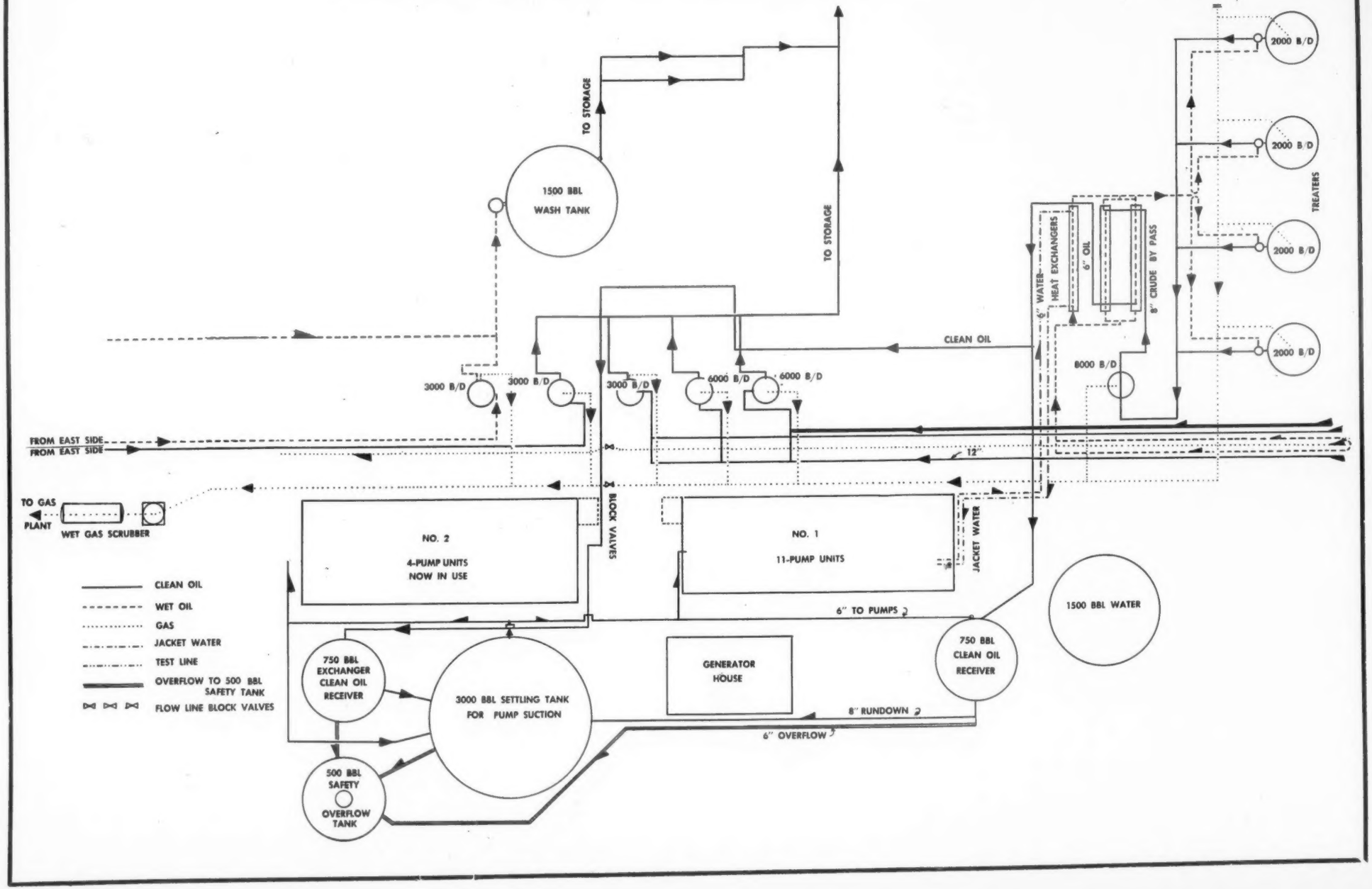
Oil flows through the usual heat exchangers attached to the treating units and into the shell of the vessel to flow in the designed path so that a uniform temperature can be applied to all of the commodity flowing through the unit. Heat is supplied in a hair-pin type combustion chamber where fuel gas is supplied through thermostatically controlled firing valves set to maintain approximately 160 F in fluid passing through treater.

As the oil enters the treating area chemicals are introduced into each of the several delivery lines in the proportion required for a complete break of the emulsion and separation of the water. These chemicals may be introduced by one of two methods, each requiring proportioning pumps. One method is to use the small drum in which the chemical is delivered by placing the container on a support so that feed lines can be connected from the drum to the proportioning pump. The other method is to obtain the chemical in bulk and place it in a larger vessel from which it is pumped as required. When using the small drum supply, two separate types of chemicals can be used simultaneously. The method is to set the pumps at the desired delivery stroke on each drum, so that each pump releases the required volume through separate lead lines so mixing is prevented before the chemical enters the



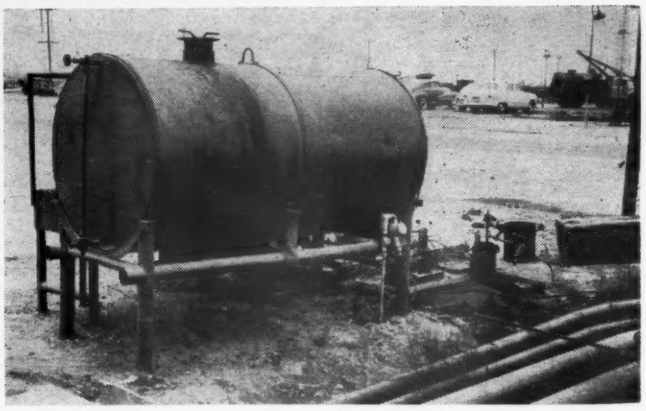
Signal board with lamps and lettering to assist operator in locating trouble in the plant.

SECONDARY TRAP INSTALLATION, BOLSA LEASE, SIGNAL OIL AND GAS COMPANY



oil stream. After entering the pipe lines, both chemicals are thoroughly mixed with the oil by pipe line turbulence and through the action of oil flowing through various bends, heat exchangers and fittings before it reaches the emulsion treaters.

The treated oil is collected from each unit in a common header returning the hot oil to the exchanger battery. In this header is a by-pass which routs the oil and the gas to an elevated oil and gas separator mounted on a 30 ft structure where production gas is separated since no oil and gas separators are employed in the field. Oil flows from the exchangers to a battery of tanks where two-750-bbl tanks and 1-3000-bbl tank are installed. All tanks are equipped with heating coils to maintain a temperature of approximately 160 F on the oil in storage. The oil flows first into the two-750-bbl tanks and thence to the 3000-bbl tank. This tank is a surge vessel for equipment which delivers the oil back to the field to operate the subsurface hydraulic pumps. The oil is delivered to the field at the elevated temperature to maintain maximum pipe line delivery conditions, and to supply heat in the subsurface hydraulic pumps to prevent precipitation of waxes at these points.



1000-gal tank used to supply treating chemicals to battery of chemical pumps. Procedure now is to use small drums on individual pumps.

Water separated from the oil is collected in a common header leading to an intricate system of skimmers and tanks equipped with facilities to prevent the escape of any oil to the disposal point. Split lines placed at the maintained water level gather the surface oil and lead it to separate sumps from which it is returned to the treating plant for reconditioning. Split lines having many small holes above the bottom of the trough deliver water to other compartments so the small globules of oil can be broken out of the water more easily.

To warn operators of any function not operating as prescribed, an electric horn is sounded. This is in accordance with more or less conventional practice, but in which the operator must determine the exact point of inefficient operation. So the operators can instantly determine the source of difficulty, a signal board is installed where it can be seen from most points in the plant. The signals are grouped on this board with colored globes over the lamps and identified by plainly printed lettering above the lamps. When the operator hears the siren and sees the lamps go on he can determine that the water well is not functioning properly. * * *

Leduc Crude To Be Used In Manufacturing Gasoline

Announcing the first shipment of western Canadian crude oil to its refinery in Clarkson, Ontario, last month, British American Oil Company also revealed plans for the construction of a $4,500,000 tanker to augment its Great Lakes fleet.

The first Canadian crude oil to be transported as far east as Lake Ontario, the 25,000 bbl were piped from the Leduc field in Alberta to Superior, Wisconsin, and were loaded aboard the British American motor vessel Elmbranch on Monday. To reach the refinery, the crude traveled 1050 miles by pipe line and 1023 miles by tanker. It was the initial shipment of 500,000 bbl of Leduc crude scheduled to be discharged at British American's Clarkson refinery this summer, after exhaustive company laboratory tests established the adaptability of Leduc crude to the manufacture of high grade gasolines and motor oils. Alberta's crude now reaches Toronto.

Previously, the company supplied its Clarkson plant with U. S. crude oil shipped directly from Toledo, Ohio. The installation of pipe line facilities between Alberta and the Great Lakes has made it possible for British American to supplement requirements at this plant with domestic production.

Ammonia Gas From Steam, Natural Gas

In a paper delivered before the midwest regional meeting of the American Institute of Chemical Engineers in Kansas City recently, H. A. Tuttle, Chemical Construction Corporation, outlined a method for production of ammonia gas from steam and natural gas. The author stated that this method is cheaper than the commonly used process, which utilizes coke or coal.

He developed the economic reason for using hydrocarbon gases as a source of material. To produce the hydrogen necessary for one short ton of ammonia requires about 35,000,000 Btu's. Translating this into the cost of raw material of energy, it is equivalent to 10,450 KWH per ton of ammonia using electrolytic process or 1.4 tons of average coke per ton of ammonia or 35,000 cu ft of natural gas per ton of ammonia. With natural gas selling at 20 cents per 1000 cu ft, coke would have to cost $5 per ton and electricity 7/10 mills per KWH to be competitive.

Blaw-Knox Expands

Chemical Plants Division of Blaw-Knox Company has announced the expansion of its operations at Tulsa, Oklahoma, to include complete plant engineering and construction services for the petroleum, gas, chemical, and process industries of the Southwest.

At the same time, the division announced the appointment of Harold V. Williams, formerly of the Blaw-Knox Chicago office, as manager of the expanded Tulsa office, and Charles B. Barry as chief engineer and head of process design and contract execution.

New African Refinery

Standard-Vacuum Oil Company has announced that Foster Wheeler Corporation has been chosen as general contractor for the new crude oil refinery to be constructed at Durban, Union of South Africa, for Standard-Vacuum Refining Company of South Africa (Pty.), Ltd.

An advance party of construction engineering experts from Foster Wheeler's New York headquarters is expected to arrive in Durban within a few weeks to begin the field survey work in connection with the project.

Maintenance of Internal Combustion Engines—Filtration of Air and Oil†

PHILIP H. MOORE*

THIS and following articles will show what happened to a conventional, single cylinder diesel engine after running for 120 hours in a dust atmosphere with no filters, with an air filter, and with air and oil filters.

Previous articles of this series appeared in the June, 1950 issue of The Petroleum Engineer and dealt with the filtration of air and oil on the spark ignition engine. This article describes similar tests on the diesel engine.

A study of the previous articles shows that there was exceptional engine wear when filters were not used, so it was concluded that the dust feed rate of 0.236 per 1000 cu ft of air was probably more concentrated than is usually encountered in practice.

This conclusion was kept in mind when planning the diesel engine tests, and it was decided that the experiments would be more instructive if the dust feed rate were reduced.

Three identical trials were run. In all cases an identical type and quantity of dust was fed to the air intake. In the first trial no filters were used. in the second the air intake was fitted with an air filter, and in the third trial the engine was equipped with both air and full flow oil filters.

Dust Atmosphere

The dust atmosphere was created by feeding an artificial dust into the air intake, which was of the same chemical composition and particle size distribution as in the gasoline engine tests. The dust was made from silica to the following size distribution:

90.4 per cent by wt.....53-20 microns
5.1 per cent by wt.....20-10 microns
2.0 per cent by wt.....10-5 microns
2.5 per cent by wt.....5-0 microns

In the gasoline engine experiments, the feed rate was 0.236 g per 1000 cu ft of air. In these experiments this feed rate was reduced to 0.036 g per hour, which corresponds to a dust concentration of 0.033 g per 1000 cu ft of air. The dust feed was intermittent because the supply apparatus would not give an unbroken flow at such a small input.

The dust was fed into the air intake for a continuous period of 20 min in every hour, for the remainder of each hour the dust feed hopper was allowed to run dry.

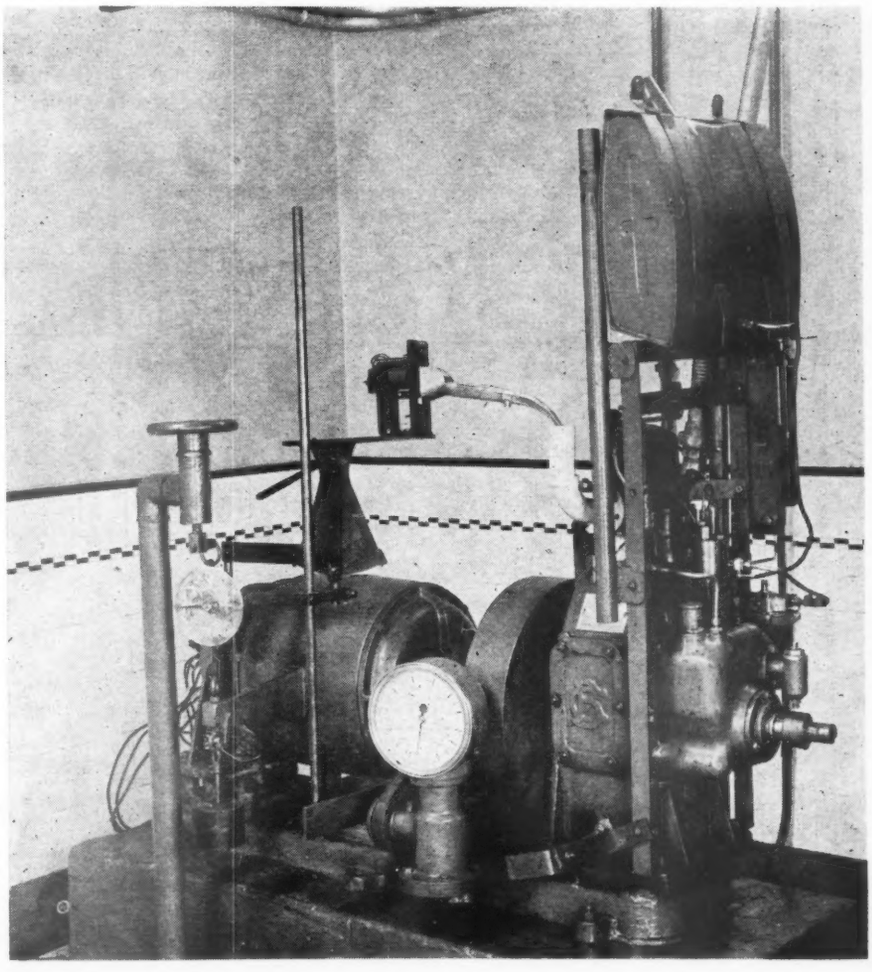
Equipment

Fig. 12 shows the layout of the test plant. The power unit was a single cylinder, 4-stroke diesel engine, fitted with wet-type liners. Its bore was 4 in. and stroke 4½ in.

The engine lubrication was by forced feed. A plunger pump lifted the oil from the interior of the pump strainer in the engine crankcase, and discharged to a pressure regulator, which was situated on the cover of the valve rocker gear. It then flowed back to the lower parts of the crankcase after passing through the engine casing and lubricating the cams, gear wheels, roller bearings, and all other working parts. The cylinder walls, floating gudgeon pin, and big end bearing pin were therefore lubricated by oil splash.

Fig. 12 also shows an electric dynanometer for absorbing the engine power output as well as a device for supplying the dust. The dust feed apparatus consisted of a hopper that fed into an electrically vibrated chute. The angle of the chute was adjustable

FIG. 12. Equipment employed for the tests on air and oil filters.



†A research sponsored by the Vokes Filter Company, England. The author is indebted to Vokes for permission to publish this article.
*Engineering consultant.

EXCLUSIVE

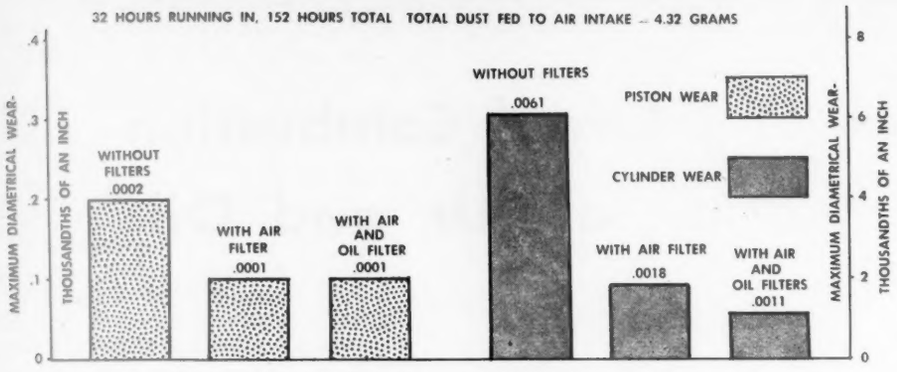

32 HOURS RUNNING IN, 152 HOURS TOTAL TOTAL DUST FED TO AIR INTAKE — 4.32 GRAMS
MAXIMUM DIAMETRICAL WEAR-THOUSANDTHS OF AN INCH
WITHOUT FILTERS .0002
WITH AIR FILTER .0001
WITH AIR AND OIL FILTER .0001
WITHOUT FILTERS .0061
PISTON WEAR
CYLINDER WEAR
WITH AIR FILTER .0018
WITH AIR AND OIL FILTERS .0011
MAXIMUM DIAMETRICAL WEAR-THOUSANDTHS OF AN INCH

DIAGRAM 14. PISTON AND CYLINDER WEAR.

to allow different flow rates.

Diagram 1, shown in the first article of this series, illustrated the air filter that was used for the second and third trials, and Diagram 2 illustrated the method by which the dust feed was directed to the intake of the air filter. Diagram 3 showed the full flow oil filter as used in the third test.

A filter was fitted into the engine fuel supply line, so that any abrasives in the fuel would not be able to influence the wear figures.

Standardization of Engine

For a true comparison, all wearable parts of the engine must be uniform before each test. This was accomplished by obtaining standardized stocks of liners, piston assemblies, bearing shells, crankshafts, valves, and valve guides, and inserting a new set of components before commencing each individual test.

Prior to each test, engine variables such as ignition tuning, valve and bearing clearances, etc. were made to conform to those figures recommended by the engine manufacturer.

Fuel and Lubricating Oil

A large quantity of fuel was obtained, which was sufficient for all the tests. This procedure means that the fuel quality was kept constant. The properties of the fuel were as follows:

Specific gravity @ 60 F = 0.850
Flash point F = 165
Viscosity (Redwood No. 1) @ 100 F = 38
Distillation =
Initial boiling point C = 190
Final boiling point C = 370
Sulfur % = 0.6
Diesel index = 52

The engine was lubricated with a non-additive mineral oil, and a stan-

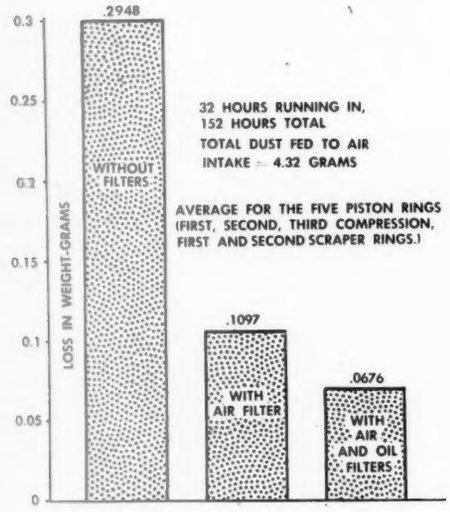

LOSS IN WEIGHT-GRAMS
.2948
WITHOUT FILTERS
32 HOURS RUNNING IN, 152 HOURS TOTAL TOTAL DUST FED TO AIR INTAKE — 4.32 GRAMS
AVERAGE FOR THE FIVE PISTON RINGS (FIRST, SECOND, THIRD COMPRESSION, FIRST AND SECOND SCRAPER RINGS.)
.1097
WITH AIR FILTER
.0676
WITH AIR AND OIL FILTERS

DIAGRAM 15. RING WEAR.

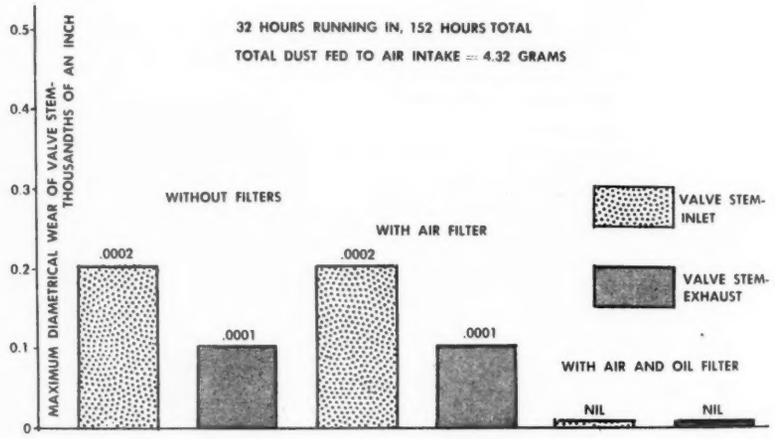


DIAGRAM 16. VALVE STEM WEAR.

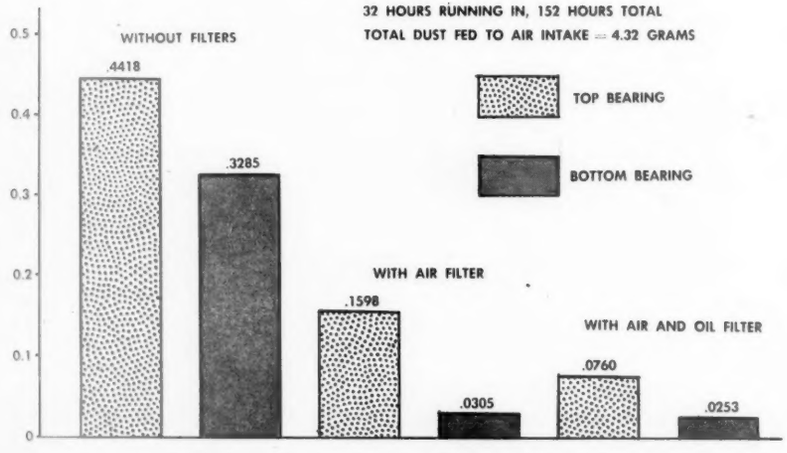


DIAGRAM 17. BEARING WEAR.

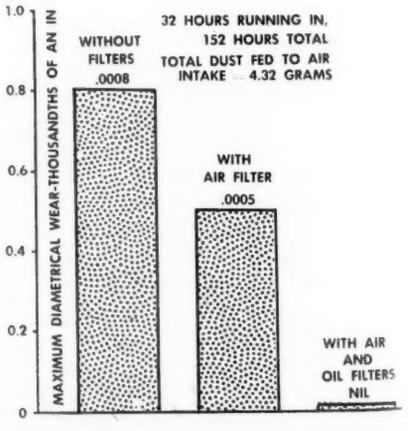
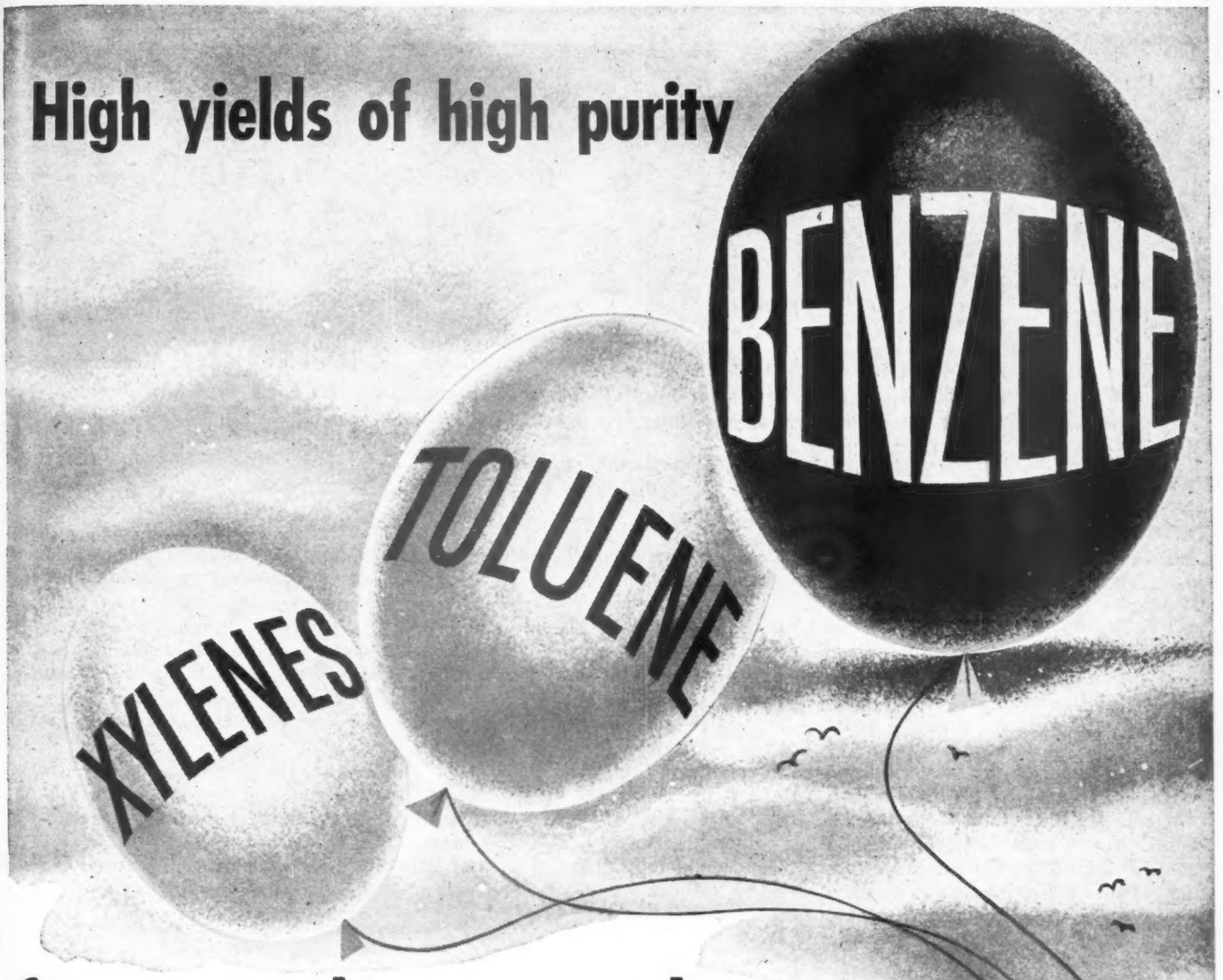

MAXIMUM DIAMETRICAL WEAR-THOUSANDTHS OF AN IN
32 HOURS RUNNING IN, 152 HOURS TOTAL
TOTAL DUST FED TO AIR INTAKE — 4.32 GRAMS
WITHOUT FILTERS .0008
WITH AIR FILTER .0005
WITH AIR AND OIL FILTERS NIL

DIAGRAM 18. CRANKSHAFT JOURNAL WEAR.

High yields of high purity



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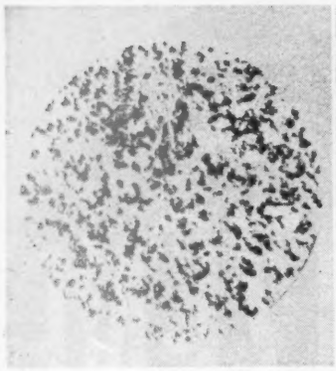


FIG. 13. Photomicrograph of the used lubricating oil after the test with no filters.

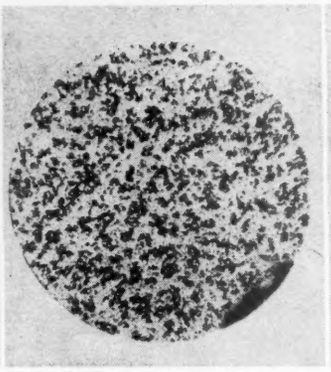


FIG. 14. Photomicrograph of the used lubricating oil after the test with air filter.

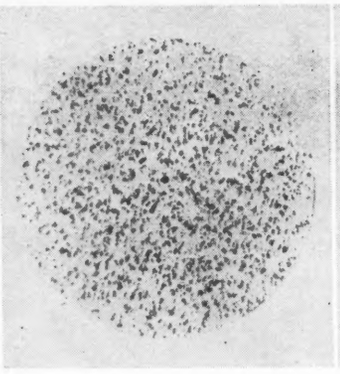


FIG. 15. Photomicrograph of the used lubricating oil after the test with air and full-flow oil filter.

FIG. 16. Photomicrograph of the washings obtained from the used oil filter.

dardized procedure was adopted for measuring and topping up.

Operating Conditions

For each trial the running-in period consisted of 8 hours at 950 rpm, ¼ full load, followed by 16 hours at 1000 rpm, ½ full load, and finally 8 hours at 1050 rpm, ¾ full load.

During the running-in period, no dust was fed to the air intake. The water jacket outlet and the sump oil temperatures were both maintained at 68 ± 2 C. After the run-in period, the engine's performance was checked by taking a power curve; if the results were satisfactory, then the trial proper was commenced.

The trial proper consisted of running the engine for 120 hours at 1100 rpm, giving 2.61 hp from the electric dynanometer. This output is approximately ½ full load. The cooling water outlet and sump oil temperatures were controlled to those ruling for the run-in period.

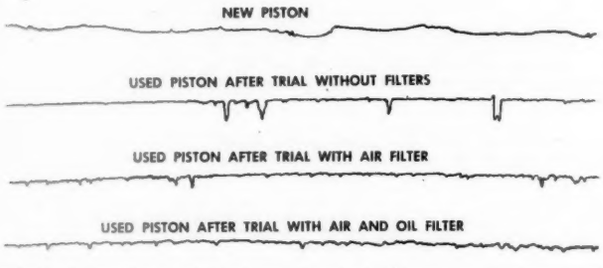
Test Procedure

After the run-in period, the engine was completely dismantled, and all parts subject to wear were either measured for size or weighed.

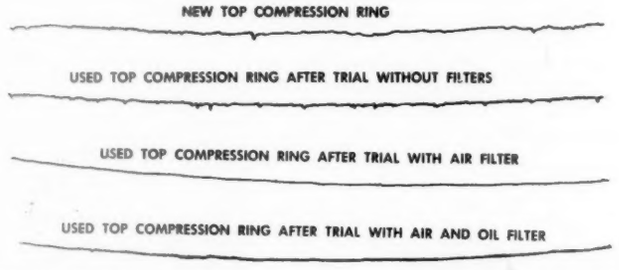
Surface profile graphs were taken of the piston, top piston ring, and bearing shell.

Next, the engine was re-assembled and the main trial commenced, without filters, but with dust feed to the air intake. At the end of the 120 hours running period the engine was dismantled, components measured, weighed etc., as the case may be. The used oil was analyzed in the laboratory, and a photomicrograph taken to show its appearance.

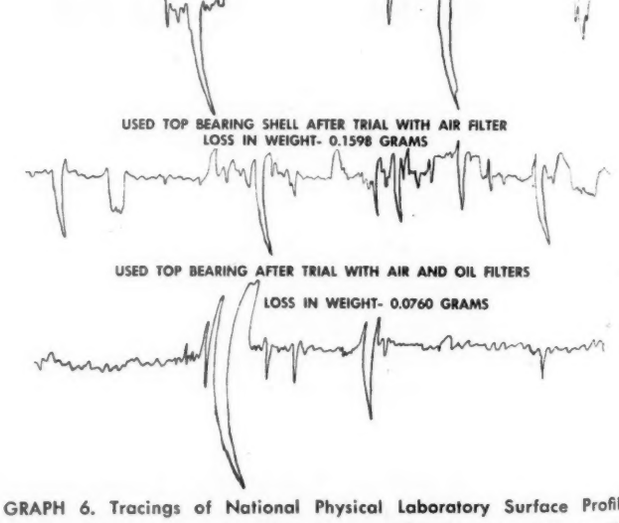
The same procedure was adopted for the second and third trials—new components, run-in period, examina-


NEW PISTON
USED PISTON AFTER TRIAL WITHOUT FILTERS
USED PISTON AFTER TRIAL WITH AIR FILTER
USED PISTON AFTER TRIAL WITH AIR AND OIL FILTER

GRAPH 4. Tracings of National Physical Laboratory Surface Profile Graphs. The records were taken in a circumferential direction on the thrust side of the skirt, at approximately two inches from the base of the piston. All magnifications are the same and the surfaces recorded are similarly positioned on each piston.


NEW TOP COMPRESSION RING
USED TOP COMPRESSION RING AFTER TRIAL WITHOUT FILTERS
USED TOP COMPRESSION RING AFTER TRIAL WITH AIR FILTER
USED TOP COMPRESSION RING AFTER TRIAL WITH AIR AND OIL FILTER

GRAPH 5. Tracings of National Physical Laboratory Surface Profile Graphs. The records were taken in a circumferential direction on the flank opposite the clearance gap. All magnifications are the same and the surfaces are similarly positioned on each ring.


NEW BEARING SHELL
USED TOP BEARING SHELL AFTER TRIAL WITHOUT FILTERS
LOSS IN WEIGHT- 0.4418 GRAMS
USED TOP BEARING SHELL AFTER TRIAL WITH AIR FILTER
LOSS IN WEIGHT- 0.1598 GRAMS
USED TOP BEARING AFTER TRIAL WITH AIR AND OIL FILTERS
LOSS IN WEIGHT- 0.0760 GRAMS

GRAPH 6. Tracings of National Physical Laboratory Surface Profile Graphs. The records were taken in an axial direction close to the middle of the bearing surface. All magnifications are the same and the surfaces are similarly positioned on each shell.

tion of engine, etc. The air filter was fitted with a new element at the commencement of both these tests, and at the completion of the tests exhaustive study was made of the matter retained by both the air and oil filter elements.

Piston Cylinder and Ring Wear

Diagram 14 shows the relative piston and cylinder wear based on maximum reduction in diameter. Diagram 15 shows the relative wear of the piston rings as measured by loss in weight. It is interesting to note from these results that not only the air filter influences wear in this section of the engine; the influence of the oil filter, though smaller in comparison, is nevertheless considerable.

Valve Stem Wear

Diagram 16 shows the relative valve stem wear based on maximum reduction in diameter. It is important to note the relative significance of the air filter on valve stem wear and the great importance of the oil filter.

Bearing Wear

Diagram 17 shows the comparative top and bottom bearing shell wear as measured by loss in weight. These results show that both the air and oil filter are equally important in reducing bearing wear.

Crankshaft Journal Wear

Diagram 18 shows that to reduce crankshaft wear an air filter alone is inadequate, and that both air and oil filters are required.

Summarizing the above wear results it can be seen that to protect these engine components, it is essential to use both the air and oil filter.

Oil Consumption

Oil consumption is not directly influenced by filtration, however, since filters affect engine wear, they consequently have an influence on oil consumption. In the first trial, without any filters, the amount of oil consumed was 1098 g. In the second trial, with the air filter, 821 g of oil were consumed, and in the third trial, with both air and oil filters, the consumption was further reduced to 611 g. Therefore, the reduction in oil consumption when using both air and oil filters amounted to 44 per cent.

Condition of Used Oil

Table 2 gives the properties of the new and used oils. These figures are self-explanatory and do not require interpretation. It is sufficient to say that they clearly show the effectiveness of the filters in removing oil insoluble matter.

TABLE 2. New and used oil analysis.

Property	New oil	Used oil (no filters)	Used oil (air filter)	Used oil (air and oil filters)
Sp.Gr. at 60 F	0.897	0.906	0.905	0.898
Redwood viscosity				
At 70 F	1565	1410	1580	1555
140 F	185	188	204	191
200 F	65	71	77	69
Closed flash point F	405	280	245	355
Analysis of deposit retained by 200 mesh gauze				
Ash per cent, grams	....	41.31	31.61	30.77
Ash per cent based on total sample, grams.	....	0.0133	0.0008	0.0002
Analysis of filtrate passing 200 mesh gauze				
Per cent insoluble in petroleum ether	....	3.03	2.66	1.03
Per cent insoluble in benzene	....	2.93	2.50	0.96
Ash per cent of benzene insolubles	....	12.62	7.30	7.35
Ash per cent of total filtrate	....	0.37	0.18	0.07
Acidity mg. KOH/gram	....	1.75	2.34	1.09

Microscopical Examination of Used Oils

Figs. 13, 14, and 15 show highly magnified samples of the used oils from the three trials.

Fig. 13, when no filters were used, showed large carbon particles throughout the field, the sizes ranging from approximately 40 by 20 microns, down to the limit of resolution. Silica was also present in sizes from 39 by 19½ microns to 19½ by 15 microns. Metallic particles were present in sizes of 10½ by 3½ microns down to 6½ by 3½ microns.

Fig. 14, when the air filter was used, showed few silica or metal particles. Most of the particles were of carbonaceous matter varying in size from 30 by 18½ microns, down to the limit of resolution.

Fig. 15, when both air and oil filter were used, showed a general reduction in particle size. No silica or metal particles could be observed, the carbonaceous particles present ranged from 10 by 6 microns, down to the limit of resolution.

Condition of Engine Surfaces

Graphs 4, 5 and 6 show highly magnified surface contours of the engine's piston, compression ring and top bearing shell respectively, at the end of each trial. Unlike the gasoline engine surface contours (graphs 1-3), there is not much difference between the surfaces with and without the use of filters. This could be caused by the longer running time having a 'rubbing-out' action on initial surface irregularities.

Examination of Used Oil Filters

The used oil filter from the third trial was washed in petroleum ether until all solids were removed. These solids, on analysis, gave the following results:

Weight of solids insoluble in petroleum ether, arrested by filter = 17.69 g

Weight of non-combustible matter contained in the solids = 2.65 g

Percentage of non-combustible solids in petroleum ether insolubes = 14.97%

Weight of solids insoluble in benzene, arrested by filter = 14.07 g

A chemical analysis of the non-combustible solids gave the following results:

Silica	7.52%
Iron Oxide	48.79%
Lead Oxide	14.72%
Aluminum Oxide	2.73%
Zinc & Nickel Oxides (as a composite of Zinc Oxide)	5.94%

The remaining 20.3 per cent was not quantitatively analyzed, but consisted of magnesium, copper, tin, and antimony oxides.

Fig. 16 shows a highly magnified sample of the deposits obtained from the oil filter. A microscopical examination of these solids showed that the larger particles consisted chiefly of carbonaceous matter, iron oxide, metals and silica. The particle sizes ranged from 75 microns downwards; the average size was less than 12½ microns.

These tests clearly indicate the importance of both air and oil filtration in reducing diesel engine wear. The dust concentration was low enough to be well within normal running conditions and therefore these experiments should be of considerable importance to operators of diesel engines. * * *

Detergents Plant Set-Up

A new plant for the manufacture of dodecyl benzene, used in making synthetic detergents, went on stream last month at Shell Oil Company's Wood River refinery. The Wood River refinery just outside St. Louis is one of the nation's largest production centers for aviation, motor fuels and lubes.

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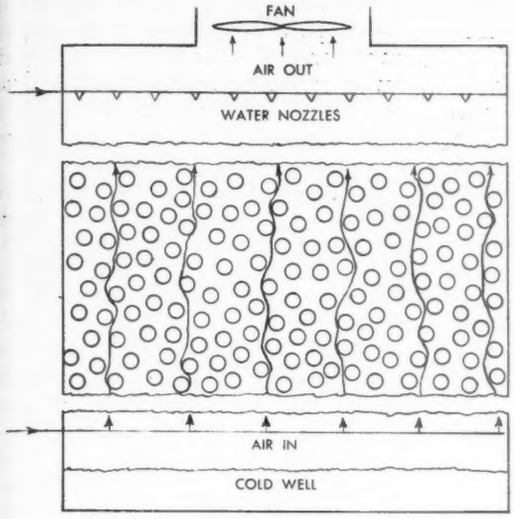


FIG. 1. Air-water contacting in cooling towers.

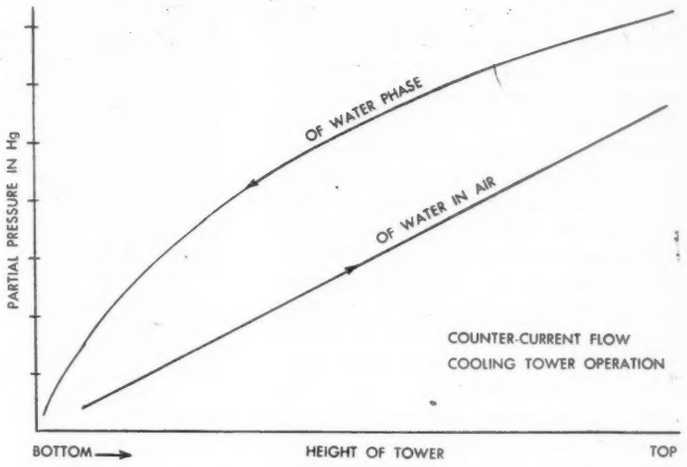


FIG. 2. Approximate partial pressure relationships.

Examination of Basic Factors Underlying Design and Operation of Cooling Towers

Methods employed in design and operation of water cooling towers with an extensive group of curves for use in making calculations.

G. L. FARRAR*

THE subject of cooling towers recently has received considerable treatment in this magazine as to applications, types and construction, and operation and maintenance[1]. In April, 1947, De Flon[2] wrote on the evaluation of cooling tower performance in an article that has since become classic. It is felt that these papers have covered adequately the applied phases of the subject, at least in so far as the needs of the petroleum refining and natural gas industries are concerned.

There are a number of ways in which thorough understanding of the basic principles involved in cooling tower design and operation will enable operators to make more efficient use of cooling towers and related equipment. Thus the concepts of humidity, heat changes, wet-and-dry-bulb thermometry, evaporation, driving forces causing heat and mass transfer and psychometry will be discussed in their application to the problem at hand.

The principles of heat and mass transfer in a system in which air is passed through finely dispersed drops of water can best be explained by referring to Fig. 1. In this diagram, which shows counter-current contacting of air and water, it is seen that the intimacy of contact depends on (1) the amount of air flowing, (2) the amount of water flowing, (3) the size of the water drops, and (4) the air and water distribution over the cross sectional area of the tower. As the number of water drops increase, the exposed area of contact between air and water is increased and the greater the contacting efficiency. The air-water distribution should be uniform to prevent channeling, and the quantities of water and air flowing should be relatively high, but considerably short of flooding conditions.

EXCLUSIVE

This discussion of pertinent factors explains the first two terms on the right-hand size of Equation 1, which is the equation for mass transfer in cooling towers. The equation will not be derived formally, but will be discussed at length.

(1) $W = KA\triangle p_m$

W = rate of water transfer from liquid to gas (for cooling water) lb/hr

K = mass-transfer coefficient, lb / (hr) / (sq ft) / (in. Hg) difference in partial pressure

$\triangle p_m$ = mean difference in partial pressure, in. Hg.

A = surface area of contact, ft^2

The value for K is best determined experimentally, since methods for calculation of K are rather complicated and the results are not too dependable. The factors on which K depends have been indicated, however.

The significance of the term, $\triangle p_m$, is shown in Fig. 2. Water comes in hot at the top of the tower, and its

*Assistant Professor of Chemical Engineering, A. & M. College of Texas. College Station, Texas.

[1]Degler, Howard E., "*Water-Cooling Towers*," The Petroleum Engineer, Vol. 22, 1950. *Part 1*, No. 3, pg. C-29 (March); *Part 2*, No. 4, pg. C-15 (April); *Part 3*, No. 6, pg. C-25 (June).

[2]De Flon, J. G., "*Evaluating Cooling Tower Performance*," The Petroleum Engineer, Vol. 19, No. 4, pg. 55, April 1947.

vapor pressure is relatively high. In a cooling tower the water is cooled as it falls from the top to the bottom of the tower (See Equation 2 and Fig. 3 below). Thus, its vapor pressure decreases as it moves through the tower. Air comes into the cooling tower in a relatively dry state. As the air passes up through the tower, its water content increases, since water is transferred from the liquid to the vapor phase by evaporation. The mean difference in partial pressure for counter-current operation is the log mean $\triangle p$; for other conditions it may be obtained by averaging several values for $\triangle p$ throughout the column. The $\triangle p_m$ is the mean driving force for mass transfer in the process. The mean driving force for sensible heat transfer is $\triangle t_m$ as shown in Equation 2.

(2) $q_s = hA\triangle t_m$

q_s = rate of sensible-heat transfer, Btu/hr

h = heat transfer coefficient, Btu / (hr) / (ft^2) / (F) difference in temperature

A = surface area of contact, ft^2

$\triangle t_m$ = mean difference in temperature, F

The heat transfer coefficient and area depend on the factors of rates, distribution, size of the water particles, as described in consideration of K and A in Equation 1. The variation in driving force, $\triangle t$, is shown in Fig 3. Counter-current flow is represented here, with air temperature at a given section always lower than the water temperature. Although the temperature pattern may vary considerably, it is approximately the one shown, in the usual case. Ordinarily about 25 per cent of the cooling in a cooling tower is due to the transfer of sensible heat (according to Equation 2) and about 75 per cent of the cooling is due to evaporation (as described below).

For counter-current operation as shown, $\triangle t_m$ is the log mean $\triangle t$; otherwise, it may be estimated in the same manner previously described for $\triangle p_m$. The heat transfer coefficient, h, should be observed rather than calculated, for the same reasons given in discussing the evaluation of K in Equation 1.

The total heat transferred (removed from the water) in a cooling tower is given by Equation 3.

(3) $q_t = q_s + Wr$

q_t = rate of total heat transfer, Btu/hr.

r = latent heat of vaporization at the water temperature.

W, q_s, as defined before.

It should be noted that "r" varies, since the water temperature varies. If the temperature variation is comparatively large the term Wr is best evaluated by graphical integration of the equation,

$$q_e = W \int_{t_1}^{t_2} r\,(dt),$$

where q_e is the heat of evaporation.

In order to appreciate fully the principles involved in mass transfer between air and water, some fundamental definitions and their applications must be considered. *Humidity* is the number of pounds of water vapor carried by one pound of air. *Per cent absolute humidity* is ratio of weight of water vapor carried per pound of air to maximum weight of water vapor that could be carried (at saturation) at the same temperature, times 100. *Per cent relative humidity* is defined as 100 p/Ps, where p is the actual partial pressure of the water vapor and Ps is the vapor pressure of water at the same temperature. *Dew point* is the temperature at which a given mixture of air and water vapor is saturated with water vapor.

It is worthy of note that air-water contacting processes fall into three categories, (1) water cooling, (2) humidification, and (3) dehumidification. The water cooling process is of course the one being discussed here; the main object of this process is to cool water for return to heat exchange equipment. The humidification process is operated so that water is evaporated into the air stream, the final amount of water vapor in the air being controlled by operating conditions. The entering air may either be hotter or colder than the water. In dehumidification the water is colder than the wet bulb temperature of the air (see below). Then water vapor condenses from the air into the water phase, and the air is cooled at the same time. Both the heat of condensation and sensible heat given up by the air as it is cooled must be absorbed by the water.

If a drop of water is brought into contact with unsaturated air, mass and heat transfer will take place according to Equations 1, 2, and 3. The processes of heat and mass transfer will continue until finally a condition of dynamic equilibrium is reached in which the heat transferred from the surroundings will exactly equal the heat of vaporization of the water evaporating at the equilibrium temperature. The dynamic equilibrium temperature thus defined is called the *wet-bulb temperature* of the air.

It may be seen that once this temperature is attained, the water can-

FIG. 3. Approximate temperature relationships.

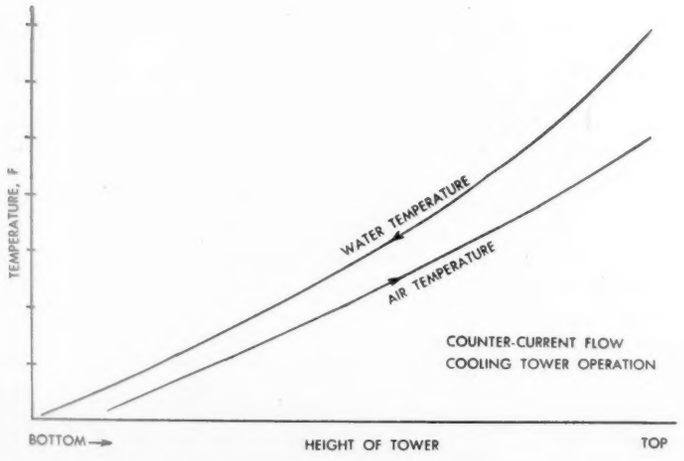
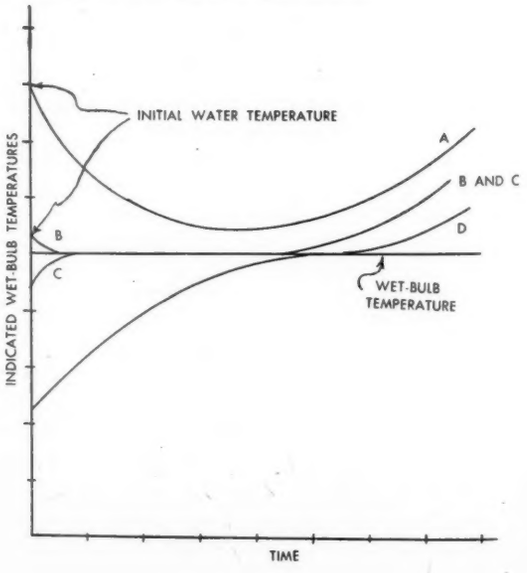


FIG. 4. Indicated wet-bulb temperatures.



not be cooled further, because its temperature will remain constant at the equilibrium temperature. It may be seen also that the drier air is at a given temperature, the lower will be its wet bulb temperature. If the air is saturated, no evaporation will occur, and the wet-bulb, dry-bulb (actual air temperature), and saturation air temperature are the same. Only a small amount of water cooling could be accomplished using saturated air, and that by mainly sensible heat transfer. Some evaporation would occur as the air temperature rose in the tower.

There is often confusion between the terms, dew point and wet-bulb temperature. Only if the entering air is saturated will the two temperatures be the same. At other times the wet-bulb temperature will be higher than the dew point, since the driving force, $\triangle p_m$ must exist if there is to be the mass transfer required by definition at the wet-bulb temperature.

It is possible, by comparing the wet-and-dry-bulb temperatures of air to determine the amount of moisture in the air. A correlation developed for this purpose will be discussed below. The determination of wet-bulb temperature is accomplished with the sling psychrometer. This apparatus consists of a base to which the wet-and-dry-bulb thermometer may be attached securely. A handle is attached to the base so that it may be swung rapidly by hand.

It is highly pertinent at this point to discuss the proper use of the sling psychrometer, since it is misused so frequently. Before swinging the psychrometer, the temperature of the wet bulb should be lowered to a point close to the wet-bulb temperature of the air. An initial trial may be necessary to determine the approximate value of this temperature, if some idea of its magnitude is not known.

The errors caused by not using the above procedure are shown in Fig. 4. In curve A the initial temperature of the wet bulb is too high. The indicated wet-bulb temperature decreases to a minimum value and then begins to increase. The reason for this is that the small amount of water on the wet bulb evaporates rapidly, and the rate of mass transfer is reduced below its equilibrium value. In Curve D the initial temperature of the wet bulb is too low, and the temperature soon rises rapidly due to the same reasons as described above. In Curves B and C, however, the wet-bulb temperature is attained rapidly and maintained for a reasonable amount of time.

The correlation mentioned above for determining the amount of water in air from wet-bulb and dry-bulb temperature measurements is known as the humidity or psychometric chart. A typical humidity chart is represented approximately in Fig. 5. The temperature is shown on the bottom abscissa, while the humid heat is represented on the top abscissa. Humid heat is defined as the heat required in Btu to raise the temperature of one pound of dry air, plus the water that it contains, by one degree F. Humid heat is then a function of humidity and is a heat capacity term. In the temperature ranges used in cooling tower operation, the specific heat of air may be considered constant at 0.24 Btu/(lb) (F), and the specific heat of water vapor may be used as 0.45 Btu/(lb) (F). The humid heat, s, may then be calculated by,

$$s = 0.24 + 0.45\,H$$

The humid heat is plotted as a function of humidity in Fig. 5. The humidity is plotted as the right hand ordinate.

Curves of humidity as a function of temperature are also plotted in Fig. 5. The parameter for these curves is relative humidity, in per cent. Obviously the humidity of air at a given temperature depends on the per cent saturation; thus the necessity for the parameter is evident. The latent heat of steam is plotted as a function of temperature for use in making heat balances. Latent heat is the first left hand ordinate in Fig. 5. Specific volume of dry air, ft^3/lb, is plotted as a function of temperature for use in computing required volumes or weights of air. Also included is the saturated volume of air, per pound of dry air, as a function of temperature. The saturated volume is the volume occupied by one pound of dry air plus its water of saturation. These volumes are plotted as the second left hand ordinate.

"Adiabatic cooling" lines are also plotted in Fig. 5. It is beyond the scope of this article to delve into the theory required for calculation of these lines. At any rate, it is sufficient to say that they are derived on the basis of no outside heat being admitted to the water-air mixture, and thus that the heat lost or gained by one stream is equal to the heat gained or lost by the other stream. If the water temperature is kept uniform (as it is in some humidifiers) the air will be humidified and its temperature will drop. For an infinite area and time of contact, the air would leave saturated at the water temperature. This "adiabatic saturation temperature" is defined by the intersection of the adiabatic cooling line with the line of 100 per cent relative humidity. Obviously, in an apparatus of finite size, the adiabatic saturation temperature will not be

FIG. 5. Humidity chart.

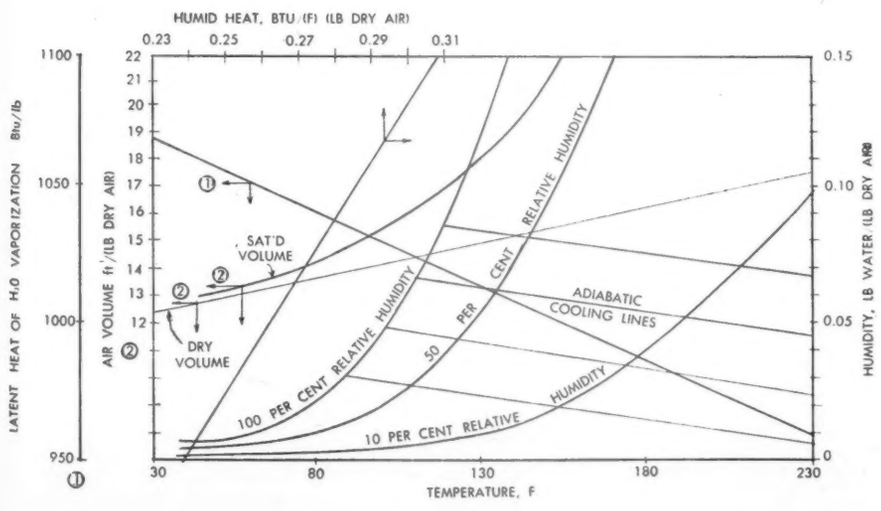
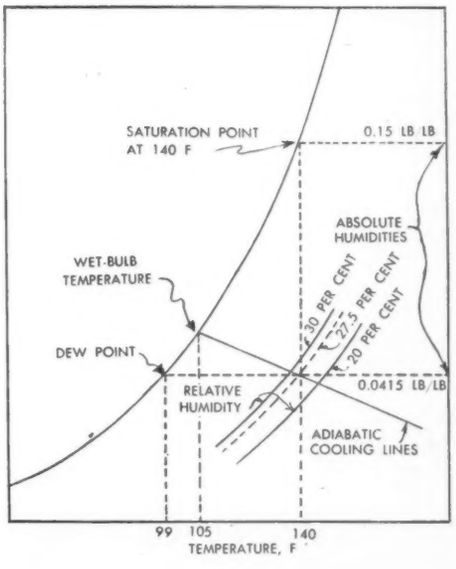


FIG. 6. Humidity chart.



reached, but the cooling would take place along a path defined by the adiabatic cooling line.

For most work encountered in the usual ranges of cooling tower work, it may be shown[3] that wet-bulb temperature for air at a given set of conditions is very close to its adiabatic saturation temperature. Then the adiabatic cooling line can be used for wet-bulb problems. For extreme ranges of temperature and humidity, appreciable errors are introduced by this procedure, and an equation of the form given by Badger and McCabe[4] should be used. Thus, for the purpose of cooling tower calculations, the adiabatic cooling curves will be used for wet-bulb determinations.

Some examples of the use of Fig. 5 are given below. It should be noted here that detailed and accurate humidity charts may be found in any of the standard chemical engineering books including unit operations, or in volumes dealing with air humidification and air conditioning.

Example 1: Air at a temperature of 140 F (dry-bulb) is found by a sling psychrometer determination to have a wet-bulb temperature of 105 F. Determine the dew point of the air, its absolute humidity, its relative humidity, and the humidity required to saturate the air at 140 F.

Solution: The intersection of the 100 per cent relative humidity line with the 105 F adiabatic cooling line is located, and the cooling line is followed to a temperature of 140 F as shown in Fig. 6. The absolute humidity at this point is found on the right hand ordinate. It is seen to be 0.0415 lb water per pound of dry air. The dew point is found by moving horizontally to the left to the saturation curve. The value is 99 F. The absolute humidity required to saturate air at 140 F is found by moving vertically to the saturation line. This value is just greater than 0.15 lb water per pound of dry air. The relative humidity is found by horizontal interpolation between the relative humidity lines of 20 and 30 per cent. This value is found to be about 27.5 per cent.

Example 2: (1) Determine the humid heat, saturated volume, and specific volume of the air in Example 1 (140 F dry bulb and 105 F wet bulb.) Also determine these values for (2) dry air at 140 F, and (3) saturated air at 105 F.

Solution:

(1) The humidity of the air at original conditions is 0.0415. At this value for H, s (humid heat) = 0.258 Btu/(F) (lb dry air). The specific volume of dry air at 140 F is 15.1 ft³/lb. The saturated volume of air at 140 F is 18.9 ft³/(lb dry air).

(2) The humidity of dry air is zero at any temperature. Other values, for saturated volume and specific volume, are the same as in (1).

(3) The humidity of saturated air at 105 F is 0.0503 lb water vapor/lb dry air. At this value for H, s = 0.261 Btu/(F) (lb dry air). The specific volume of dry air at 105 F is 14.2 ft³/lb. The saturated volume of air at 105 F is 15.4 ft³/(lb dry air).

The material and heat balance considerations for a cooling tower operating under steady state conditions are of considerable importance in evaluating the performance of the unit. Actual results obtained may then be compared with those predicted in the design.

The overall material balance equations are,

(4) $L_2 - L_1 = Z\ (H_2 - H_1)$ (Water balance)

(5 $V_2 - V_1 = L_2 - L_1$ (Vapor balance)

1, 2 refer to air entrance and water entrance, respectively.

V = vapor quantity, lb/hr

Z = flow of dry air, lb/hr

other quantities as previously defined.

The overall heat balance equation may take several forms, as shown by Walker et al[5].

For working with cooling towers,

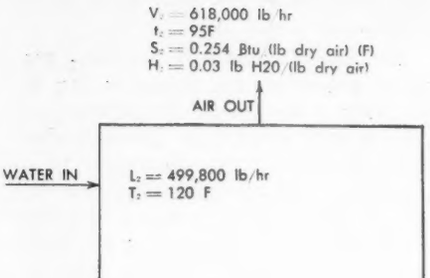

V₂ = 618,000 lb/hr
t₂ = 95F
S₂ = 0.254 Btu (lb dry air) (F)
H₂ = 0.03 lb H20/(lb dry air)
AIR OUT
WATER IN
L₂ = 499,800 lb/hr
T₂ = 120 F
V₁ = 606,000 lb/hr
t₁ = 80 F
W = 600,000 lb/hr
S₁ = 0.245 Btu/(F) (lb dry air)
H₁ = 0.01 lb H20/(lb dry air)
AIR IN
WATER OUT
L₁ = 487,800 lb/hr
T₁ = 90 F

FIG. 7. Cooling tower heat and material balance.

the signs are changed in Equation 2b of Walker, and used here as Equation 6.

(6) $L_2\ (T_2 - T_1) = Zs_1\ (T_1 - t_1) + Z\ (H_2 - H_1)\ r_{T_1} - Zs_2\ (T_1 - t_2)$

T = water temperature

t = air temperature

r_{T_1} = latent heat of water at the entering water temperature.

Other terms as previously described.

The application of these equations is illustrated in E mple 3.

Example 3: 1000 gm of cooling water at 120 F (measurement corrected to 60 F) are pumped to a cooling tower. Temperature of the water leaving is 90 F. 10,000 lb/min of air at 80 F dry bulb and 65 F wet bulb are admitted to the tower. The air out is at 95 F dry bulb and 90 F wet bulb. Check the consistency of the data by computing the exit water temperature and comparing with the observed water temperature. Complete the heat and material balance.

Solution: A diagram of the unit showing operating conditions is shown on Fig. 7. From the psychometric chart, it is found that $H_1 = 0.01$ lb water per lb of dry air and $H_2 = 0.03$ lb water per lb of dry air.

$Z = 10{,}000 \times 60 = 600{,}000$ lb/hr

$L_2 = 1000$ gpm $= 8{,}330$ lb/min $= 499{,}800$ lb/hr

$T_2 = 120$ F; $t_1 = 80$ F; $t_2 = 95$ F

$r_{T_1} = 1043$ Btu/lb (assuming 90 F as T_1; if some other value is obtained, r_{T_1} will be corrected proportionately.)

$s_1 = 0.245$ Btu/(F) (lb dry air);

$s_2 = 0.254$ Btu/(F) (lb dry air)

$499{,}800\ (120 - T_1) = (600{,}000)\ (0.245)\ (T_1 - 80) + 600{,}000\ (0.03 - 0.01)\ 1043 - (600{,}000)\ (0.254)\ (T_1 - 95)$

$59{,}976{,}000 - 499{,}800\ T_1 = 147{,}000\ T_1 - 10{,}760{,}000 + 12{,}520{,}000 - 152{,}300\ T_1 + 14{,}490{,}000$

$494{,}500\ T_1 = 43{,}726{,}000$

$T_1 = 88.5$ F

This compares favorably with the measured exit temperature of the water.

From Equation 4,

$L_1 = L_2 - Z\ (H_2 - H_1)$

$L_1 = 499{,}800 - 600{,}000\ (0.03 - 0.01) = 499{,}800 - 12{,}000$

$L_1 = 487{,}800$ lb/hr

From Equation 5,

$V_2 = V_1 + L_2 - L_1$

$V_1 = 1.01\ (600{,}000) = 606{,}000$ lb/hr

$L_2 - L_1 = 12{,}000$ lb/hr (from above)

$V_2 = 606{,}000 + 12{,}000 = 618{,}000$ lb/hr. * * *

[3]Lewis, W. K., Trans. A.S.M.E. 44 325 (1922).
[4]Badger and McCabe, *"Elements of Chemical Engineering,"* 2nd Ed., Mcgraw-Hill, pg. 253, Eq'n. 129.
[5]Walker, Lewis, McAdams, and Gilliland, *"Principles of Chemical Engineering,"* 3rd Ed., McGraw-Hill, pg. 601, Eqns. 2a-2d.

Natural Gasoline, LPG Gain Importance

Salt domes make raw-material storage containers for LPG, gasoline in off-season periods, NGAA men told

The natural gasoline-liquefied-petroleum-gas industries have relatively low-cost, large capacity storage basins on hand to store LPG etc., in off-peak times, Frank Matheny of Sid Richardson Gasoline Company told the Natural Gasoline Association of America meeting in Tulsa, Oklahoma April 25-27. These 'raw material' storage containers are the salt domes that intersperse with oil and gas fields from the Gulf Coast to Illinois and elsewhere, Matheny pointed out.

The routine sketched by Matheny is comparatively simple. An old, or even a new well entering a salt dome is fitted with the proper size and amount of tubing, water pump is moved in and quantities of water as may be desired are pumped into the well, either down through the casing-well-bore interspace and back up through the tubing or vice versa. This water dissolves the salt gradually, producing a cavity of a size and capacity determined by the extent of the salt bed and the amount of water pumped in. Three thousand to 5000 bbl of water per day are pumped into the well. Experience has shown that about 6.3 bbl of water are required to remove one barrel of salt, and that the water temperature has little effect on the solution rate or concentration. Results show also that the final storage capacity of the dissolved-out portion of the salt dome can be determined with reasonable accuracy by metering the amount of fresh water going in, calculating capacity as one barrel per 6.3 bbl of water admitted, or by such other solubility factor as may be determined from experimental results obtained in a specific operation.

Storage Tank Costs

Costs of such storage 'tanks' vary from 50 cents per barrel of capacity to 15 cents per barrel depending on the individual situation, Matheny indicated. Return of LPG to above-ground, steel tankage has been of the order of 99 per cent-plus. Pumping pressures are reported to be comparable to those for plant-to-tankcar transfers. Some LPG dealers, especially in the southeast, are engaged now in preparing "thousands upon thousands" of barrels of this type of storage in the salt domes of Mississippi, Alabama, and other contiguous states, from which they are taking and will take adequate supplies of LPG to meet peak winter or other demands over and beyond their normal above-ground capacity. Michigan, Ohio, Western Pennsylvania and Western New York also have salt domes near large-demand areas that can be converted to this purpose. This or other system of off-peak storage will aid in converting LPG from a by-product material with "feast-famine" alternating periods into a main product the supply of which can be assured at any time, Matheny assured the association.

Natural Gasoline in Fuels

The milder engines being marketed today 'superimpose' mechanical octane numbers to and on the chemical octane numbers of fuels, which provides ultimate advantages to all fuel manufacturers, said T. W. Legatski and L. A. McReynolds of Phillips Petroleum Company, in discussing the role of natural gasoline in producing better fuels. Natural gasoline as a valuable fuel component has good anti-knock ratings regardless of the method of test employed, but has also other good properties such as volatility, which may enable the fuel refiner to utilize them in the strong turn toward higher octane numbers, mechanical or otherwise, these technologists said. The trend during recent years shows that engine design has been such that research test method results correlate better with road performance than do motor method results. This is in contradiction to earlier (1930-40) results in which the motor method road performance data correlated better. This means an advance in the lessening of engine conditions severity, motor method conditions being the more severe. Cracked products, olefins, aromatics, etc., show greater spread between Motor and Research ratings than do paraffins and isoparaffins, that is, greater 'jump.' Natural gasoline is relatively insensitive to anti-knock severity conditions, being composed mainly of paraffins and some isoparaffins. Chemical octane numbers refer to octane or anti-knock properties imparted by the chemical composition of the fuel components. Mechanical octane number improvement refers to changes in engine design by which the engine for any set of conditions requires lower chemical octane numbers to perform satisfactorily. Therefore mechanical octane number improvement means development of better mechanical design in engines. Better mechanical design means lower requirements in chemical composition and finally higher yields per barrel of crude, more power output per barrel, better fuel, engine, and national economy, say Legatski and McReynolds. LPG fuel is almost ideal for engines, they point out; the big problem in the general adoption of LPG for motor and similar fuels is one of geographical distribution, not of properties nor of ways and means to adapt it to existing engines. Superfractionation is one of the best means for isolating the needed components for motor fuels from natural gasoline. One of the outstanding newer developments is that of ethylenenalkylate, in which propane and butane-isobutane are fed to cracking furnaces and the decomposition products are then alkylated with a catalyst to produce diisopropyl, of extremely high octane rating.

Hydrate Formation

Natural Gas-Hydrate formation and decomposition have been tremendously important subjects for many years and Dr. D. L. Katz, University of Michigan, along with R. Kobayashi, H. J. Withrow, and G. B. Williams have made a report showing the effect of lowering the hydrate formation or existence temperature in the presence of NaCl, ethanol and other diluents. This reduction of temperature may range from 4-6 degrees F for 10 per cent NaCl in water, to 18-20 F for 20 per cent NaCl; 4-6 F 15 wt. per cent of ethanol in water, these men reported.

Internationally known Dr. Walter J. Podbielniak, whose photo is shown elsewhere in this issue, was awarded the NGAA Hanlon Award for outstanding service to the industry. Dr. Podbielniak is responsible for the development of modern methods for analysis of complex mixtures of light hydrocarbons, now used universally in the industry; ultra-modern methods for fractionation, and fluid-fluid contact processes, which tend to revolutionize the industry's methods. ★ ★

Your questions on refining and gas processing problems answered here
Send yours in today!

THE TECHNICAL FORUM

Gum Inhibitor

Q What amounts of the various inhibitors on the market should be added to gasoline for different percentages of "potential gum" or "copper dish gum," for typical thermally and catalytically cracked products? What is the relationship between gum-forming tendency, "potential gum," induction period, etc., and the quantities of chemical required for a satisfactory motor fuel? *C. D. E.*

A It would be indeed a great help to the refiner if he could predict the dosage of oxidation inhibitors on the basis of some laboratory test such as potential gum, induction period or the like, made on thermal and catalytical naphthas.

Unfortunately, the situation is much more complicated. The response of thermally and catalytically cracked naphthas to oxidation inhibitors is influenced by numerous factors, the nature of the parent crude, various conditions of cracking operations, type of inhibitor used, manufacturing stage at which the inhibitor is added, etc.

For More Detailed Replies

Especially for space reasons, Technical Forum Consultants cannot always answer questions as completely as is desirable. In fact, the answers to many of these questions might well require a full article or more to do the subject justice. In case inquirers may wish to obtain more detailed information they should feel free to write the Panel member direct; any communication may be directed to a Panel member in care of the Forum Editor, and will be transmitted to the member without delay.—Panel Editor.

While, generally speaking, catalytically cracked naphthas are more stable to oxidation, and therefore require less inhibitor than thermally cracked, very many exceptions may be cited. Evidently, the effect of type of cracking may be overshadowed by the combined effects of the other aforementioned variables. Furthermore, the picture is also complicated by the length and conditions of storage life expected for the finished gasoline. For instance, a refinery supplying gasoline to a nearby large consuming area in the North would need less inhibitor, than another refinery filling an order for long storage at a desert or South Seas' base.

Another factor, of more recent origin, influencing the dosage of oxidation inhibitors, is the use of metal deactivators which tend to remove one of the causes of the deterioration of gasolines in storage.

The above discussion explains why the selection and correct dosage of oxidation inhibitors are still in the class of "tailormade" jobs. Every refinery has to evaluate the available gasoline blends and their component naphtha streams, and to arrive at a decision based on the study of all factors involved. With stabilized operating and marketing conditions in a given refinery, certain dosages of preferred inhibitors will develop, but the experience cannot be directly applied to another refinery.

Actually, many refiners over-inhibit their production, adding to *all* motor gasolines the amount of inhibitor required for the *least stable* grade, this being done in the belief that the additional cost of inhibitor provides a larger safety factor for the production, and relieves the management of tedious evaluation work. The latter involves long storage of samples with and without the inhibitor. To illus-

Description of samples

	Crude oil source	Type of gasoline	Refining method	Inhibitor lb/1000 bbl	TEL ml/gal
30	Mid-Continent	50% Thermally cracked + 50% steam refined	Caustic wash	A-naphthol-35	2.5
31	Mid-Continent	+ 50% steam refined	Caustic wash	UOP No. 4-6	2.41
32	Mid-Continent	75% Catal. cracked + 25% Steam refined	Caustic wash	UOP No. 4-2.4	0.45

Inspection of original gasolines

	Gravity °API	ASTM IBP	Dist. FBP	Bromine number	% S	O.N., M.M.	ASTM oxygen bomb stab., min.	ASTM gum mg/100 ml	Copper dish gum, mg/100 ml
30	62.6	105	378	42	.02	79.9	715	1.3	4.4
31	62.5	100	375	43	.02	79.9	470	1.2	7.6
32	61.7	98	365	52	.02	80.1	735	3.9	16.6

Inspection after six months desert storage in cans

	ASTM oxygen bomb stab., min.	ASTM gum mg/100 ml	Copper dish gum, mg/100 ml
30	405	16.3	37.0
31	235	5.0	27.0
32	380	11.7	43.0

Effect of inhibitors on the induction period test of gasoline

	Inhibited: Induction period of gasoline, min.	Uninhibited: Induction period of gasoline, min.	Increase in I.P. Due to inhibitor, min.
30	915	60	855
31	455	60	395
32	660	360 (est.)	300

trate, in one refinery, both the regular and premium grades of motor gasoline are inhibited with 2 lb. of N,N¹ di- secondary-butylparaphenylene diamine per 1000 bbl. The former consists of 2/3 thermally cracked naphtha and 1/3 straight-run naphtha, and the latter, is all catalytic. In the same refinery, aircraft gasoline, also all catalytic, is inhibited with 6-8 lb/1000 bbl of the same inhibitor.

If the inquirer wishes to study the problem in greater detail, he should be referred to the now declassified report of the Coordinating Research Council "1943 Desert Storage Tests on 80 Octane Number All-Purpose Gasoline Stability," New York, September 1944 which is undoubtedly the most comprehensive work in this field. A great many data will be found on thermally cracked gasolines and their blends with straight-run naphthas, but very few on catalytic stocks.

This is understandable because in 1943, practically no catalytic naphtha was used in the manufacture of motor gasolines, the whole production of catalytic stock having been absorbed by the aviation fuel blends.

From the CRC report, we have singled out the following data on samples 30, 31, and 32, which give some idea of the difference in the response of thermally cracked and catalytically cracked naphthas to oxidation inhibitors.

J. H. Happel

Sunray Oil Leases 10,000 Bbl Refinery

Sunray Oil Corporation has leased the complete refining facilities of the Rock Island Oil and Refining Company, Inc., at Sunray (Duncan), Oklahoma, and will operate the plant as an adjunct to Sunray's catalytic cracking refinery adjoining the leased property.

The processing equipment of the plant leased by Sunray consists primarily of a crude oil topping and vacuum unit, a thermal cracking unit, and a gasoline recovery unit. The rated throughput is 10,000 bbl of crude oil per day and Sunray's operation of the plant will assure an additional 2500 bbl per day of gas-oil for the company's catalytic cracking unit, increasing its runs to about 16,000 bbl per day. The Sunray (Duncan) refinery is processing to crude stills approximately 25,000 bbl of crude oil per day, an all-time high.

The addition of these facilities to Sunray's refining operations gives the company approximately 45,000 bbl per day refining capacity in Oklahoma, including about 10,000 bbl per day at its Allen, Oklahoma, thermal cracking plant.

Calso Ships First Aviation Gasoline

The California Oil Company has announced that its first shipment of 15,000 bbl of grade 100/130 aviation gasoline has left Calso's Perth Amboy, New Jersey refinery for delivery to the United States Air Force. In a joint statement, E. W. Endter, president of The California Oil Company, and C. E. Allen, president of the California Refining Company, stated: "Aviation gasoline production facilities were installed by California Refining as part of this company's military preparedness program. The aviation gasoline is being manufactured exclusively for the armed forces."

The new Calso refinery expansion program has just been completed. It includes a large Houdriflow catalytic cracker and a modern sulfuric acid alkylation unit. Originally planned to meet the needs for the higher octane gasolines required by high-compression automobile engines, the refinery has been modified to produce high octane aviation gasoline in view of increased military requirements.

Texas Standard to Build Processing Facilities

Standard Oil Company of Texas has awarded a contract to Catalytic Construction Company, Philadelphia, Pennsylvania, to engineer and construct the processing facilities for its large refinery expansion program at El Paso, Texas.

The new facilities will include a reduced crude vacuum unit, Houdriflow catalytic cracking unit, synthetic distillation, gas plant and treating units, and an alkylation unit.

T. Ellwood Webster, president of Catalytic Construction Company, states that engineering has begun and it is planned to begin construction work at El Paso by September 15, 1951. The entire program is scheduled for completion by June, 1952.

Phillips Plans Sulfur Plant

Phillips Chemical Company is planning construction of a large sulfur extraction plant in West Texas, according to an announcement made by K. S. Adams, chairman, and Paul Endacott, president, of both Phillips Chemical Company and its parent, Phillips Petroleum Company.

This plant is designed to extract from natural gas nearly a quarter of a million pounds of elemental sulfur per day and will be situated in the Permian Basin oil fields near Goldsmith. The output will be used by the company in connection with its ammonium fertilizer plant at Adams Terminal near Houston.

Cities Service FCC Unit Breaks Initial Run Record

Cities Service Oil Company's East Chicago Fluid catalytic cracking unit has made petroleum processing history by completing a record initial run of 785 days before being shut down for its first turn-around.

In the course of its record run the Cities Service unit processed into high test gasoline a total of 11,914,000 bbl of virgin gas oil.

At the same time, the company announced that another of its cat crackers, a fluid unit at the Cities Service Lake Charles refinery, is setting an all-time record for continuous operation on other than an initial run. This unit has been operating more than 900 days since its last turn-around and is still going strong, the announcement says.

Sunray Puts New LPG Tank Cars in Service

The delivery of 200 newly purchased liquefied petroleum gas (LPG) tank cars and 100 new cars to be operated by them on a lease basis, has been made to Sunray Oil Corporation refineries and gas-gasoline plants in the Southwest.

Sunray's new high pressure cars are each 10,000 gal capacity. The acquisition will give the company shipping control over its growing volume of products from its Earlsboro, Oklahoma, Midway, Arkansas, Benton and West Tepetate, Louisiana, and its Texas field production units including the new Scurry County gasoline plant near the town of Snyder.

Texaco Develops New Rig To Test Gears, Lubricants

The Texas Company has announced that it has developed an improved method for testing the critical lubrication requirements of high-speed precision gears.

The new test rig is based on a machine originally designed by Pratt and Whitney Aircraft for bench testing gears and lubricants. It incorporates design features that extend the speed and load range. The Texaco modification permits speeds up to 16,000 rpm under loads that are the equivalent of those loads present in operations where small gears transfer 5000 hp.

The Texaco test rig is basically a 4-square gear tester. Preliminary studies for developing the rig were begun about 5 years ago. A test run of the high-speed precision gears extends from the start until a failure of the gear surfaces appears. Runs are made at constant speed with progressive loading. (See photo page C-14.)

NEWS

Sun Oil To Install New Houdriforming Unit

Houdry Process Corporation has completed arrangements for the installation by Sun Oil Company of a Houdriforming unit at its Marcus Hook, Pennyslvania refinery.

The new Sun Houdriformer will have a charging capacity of 11,000 bbl of naphtha per calendar day. Operating in conjunction with the equally new Sun Arosorb process for aromatics purification, the new installation will produce more than 13,000,000 gal per year of chemical grade benzene, 30,000,000 gal per year of chemical grade toluene, and 15,000,000 gal per year of aromatic aviation gasoline blending stock for the production of Grade 115/145 aviation fuel. Engineering of the plant is in progress, and completion of construction is expected by fall of 1952.

The new Houdriform catalyst is capable of operating continuously for very long periods without regeneration. If desired, however, this novel catalyst can be regenerated in place for operating flexibility.

In addition to the ability to produce aromatics by the Houdriforming process, high gasoline yields are obtainable as shown in the following table of pilot plant operations:

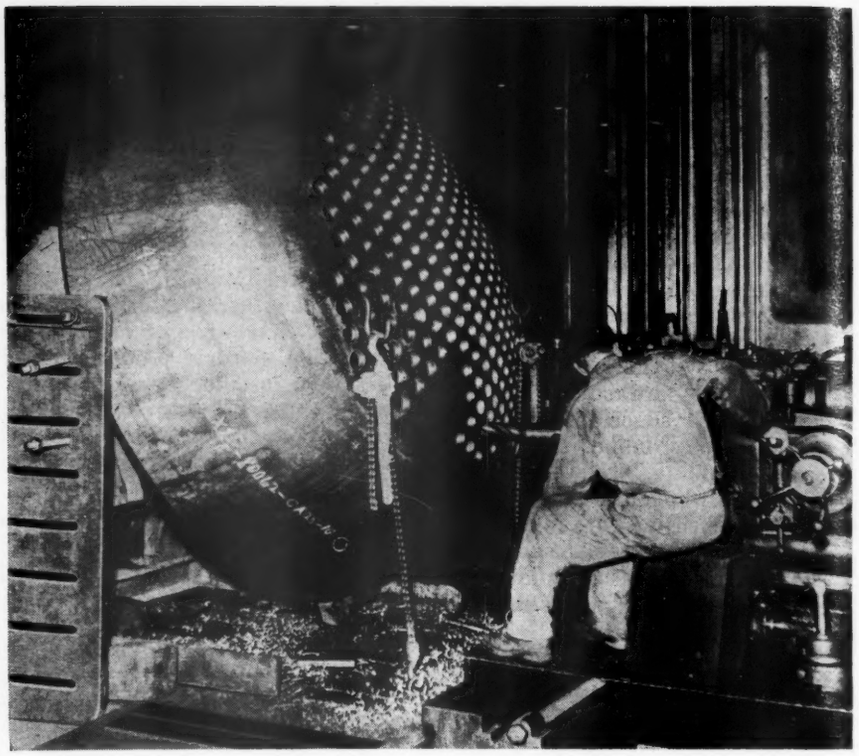
Research octane No., unleaded	Volume % yield gasoline	Reid vapor pressure gasoline
85	93.8	6.3
90	92.8	8.5
92	91.6	10.0
95	90.0	10.0

Standard Will Build Unit Onto Kansas Refinery

Plans for the construction of a catalytic cracking unit and an alkylation unit at the Neodesha, Kansas, refinery of Standard Indiana were announced by Dr. M. G. Paulus, vice president in charge of manufacturing.

The addition of these two units will bring the processing facilities at Neodesha into balance. Construction of the units will be begun soon, with completion scheduled about the end of 1952.

Late last year Standard announced plans for expansion of its Neodesha refinery. The first step of this expansion involved revamping and additions to the crude oil distillation, coking, and rerunning units to increase the refinery crude oil capacity from 10,400 to 19,700 bbl per day. Work on this phase of the program is already under way and is scheduled to be completed by early next year.



Drilling holes in one of 3 internal heads designed for Gulf Oil Corporation's new 60,000-bbl-per-day cracker at Port Arthur, Texas. Designed by M. W. Kellow Company, the muffler will be used in the exhaust stack of the Fluid cat cracker with the world's largest reactor-throughput, to eliminate the roar of escaping, high-velocity flue gases produced during the high-temperature regeneration of catalyst.

New Petrochemical Company

Formation of the American Petrochemical Corporation for the manufacture of essential chemicals from petroleum hydrocarbons, has been announced by Harvey S. Firestone, Jr., chairman of the board of the Firestone Tire and Rubber Company, and W. Alton Jones, president of Cities Service Company.

The new company has developed plans for construction of a large modern chemical plant, the production of which ultimately would encompass the broad fields of plastics, synthetic rubber, additives for lubricating oil, cracking catalysts, anti-freeze, and many high volume petrochemicals.

A site at Lake Charles, Louisiana, is under consideration for the new plant. Cities Service owns and operates at Lake Charles a 160,000-bbl refinery, which would be a source of supply of light hydrocarbons for the chemical plant. Firestone Tire and Rubber operates a government-owned synthetic rubber plant adjacent to the refinery. Ownership of the new corporation will be equally divided between Cities Service Oil Company and Firestone Tire and Rubber Company.

Shell Plans Benzene Plant

More than 19,000,000 gal a year of benzene, now in critically short supply and urgently needed in the defense program, will be made from petroleum in a new plant to be built by Shell Oil Company at its Houston, Texas, refinery.

According to F. S. Clulow, vice president in charge of manufacturing, the new plant is Shell's second. The other, in which Shell made the first benzene ever produced in commercial quantities from petroleum, is in California. That plant was first operated in 1947, during a temporary shortage, and has been in full production since March, 1950. The plant will also make 38,000,000 gal a year of toluene concentrate, an ingredient of high octane aviation gasoline.

As raw material, the plant will use a gasoline fraction which will be put through a "platforming" unit that processes it at a temperature of about 900 F. Construction of the plant will be handled by two firms. The platforming unit will be built by Procon, Inc.; the aromatic concentration section by Foster Wheeler.

What's the Trouble With Caustic Regenerative Gasoline Treating

C. W. RIPPIE*

TWENTY-FIVE years ago it was developed that caustic soda solutions reacted with mercaptan sulfur compounds in cracked gasolines and steam regeneration of the caustic soda solution hydrolyzed the sodium mercaptide compound. The liberated mercaptans had a boiling point of 42 F to about 400 F so that open steam in the regenerating tower carried the mercaptan sulfur compounds out of the system. Accordingly, the caustic regenerative gasoline treating plants were largely developed when thermal cracked gasolines constituted the major portion of the mercaptan sulfur compounds to be removed from the gasoline.

Further, patent literature shows that secondary mercaptans are prepared from hydrogen sulfide and secondary olefin hydrocarbon. By the same token, this secondary mercaptide decomposes at elevated temperatures of boiling caustic soda solutions to liberate hydrogen sulfide and the olefin. The hydrogen sulfide forms sodium sulfide and gradually increases the concentration of sodium sulfide in the regenerated caustic soda solution. Accordingly, even a hydrogen sulfide-free gasoline charged to a caustic regenerative plant would develop considerable amounts of sodium sulfide after continued use.

As the sodium sulfide concentration increases in the caustic soda solution, the caustic soda solution becomes saturated with respect to the sulfide ion, which in turn reduces the amount of mercaptan sulfur that can be extracted from the sour gasoline and the amount of mercaptan sulfur that can be removed in the steam regenerative tower. Gradually the fixed sulfide concentration inactivates the caustic soda solution so that increasing amounts of caustic soda must be withdrawn from the system and replaced with fresh caustic soda.

The boiling points of a number of mercaptan sulfur compounds are listed in the following table. The last five mercaptan compounds have an aromatic base and boiling points from 271 to 410 F.

Mercaptan	Boiling point degrees F
Methyl	42
Ethyl	97
N-propyl	154
Iso-propyl	140
N-butyl	208
Sec-butyl	190
N-amyl	259
Sec-amyl	243
N-hexyl	302
Sec-hexyl	288
N-heptyl	347
Sec-heptyl	333
N-octyl	390
Sec-octyl	375
N-nonyl	435
Sec-nonyl	420
Benzenethiol	336
3-methylthiol	383
2-ethylthiol	410
Cyclopentanethiol	271
Cyclohexanethiol	374

In order to correlate the boiling points of mercaptan sulfur compounds with the boiling points of various concentrations of caustic soda solutions, it should be noted that 10 per cent solution boils at 218, 20 per cent at 226, 30 per cent at 240, 40 per cent at 262 and 50 per cent at 282 F.

The increased percentage of catalytic cracked gasolines today have obsoleted the conventional steam caustic regenerative treating plant because the aromatic mercaptans have such high boiling points when they are liberated in the regenerating tower and cannot be removed under normal operations. Accordingly, these aromatic mercaptans form sodium sulfide compounds with the boiling caustic soda solution and gradually saturates the caustic solution so that it will neither absorb mercaptans from the sour gasoline nor regenerate mercaptans in the steam regenerating tower. Under these conditions the caustic regenerative plant does not remove a maximum percentage of mercaptan sulfur from the treated gasoline and subsequently lowers the octane improvement of the gasoline when blended with lead tetraethyl. Even if subsequent treating process is used, the corresponding amount of disulfide sulfur is about as detrimental to the susceptibility of tetraethyl lead as mercaptan sulfur.

Fortunately, the American Development Electrolytic process oxidizes the aromatic mercaptans readily to corresponding disulfide. These disulfides are removed at low temperatures by either settling or naphtha wash and do not form the corresponding sulfide sulfur in the caustic soda solution. Accordingly, the treating life of the caustic soda solution is increased materially. Likewise, the continued increased mercaptan sulfur removal from sour gasoline improves the octane rating with tetraethyl lead so that favorable payout time of the ADC process results for most catalytic cracked and thermal cracked gasolines. * * *

*American Development Corporation.

Phillips Refining Awarded

Employees of the Sweeny, Texas, refinery of Phillips Oil Company received a National Safety Council plaque and an American Petroleum Institute certificate of safety for outstanding achievements during 1950. Phillips Oil Company is a subsidiary of Phillips Petroleum Company.

C. C. Tate, manager of Philips refining department, presented the two awards to G. A. Ibach, superintendent of the Sweeny refinery, at an employee group meeting at the plant. In recognition of their fine safety record, the company also honored employees with individual awards. The API certificate is given for a million-hour safety record.

First Fluid Hydroformer

Pan-Am Southern Corporation will build the first commercial fluid hydroformer at the company's Destrehan, Louisiana, refinery. The unit will have a feed rate of 2000 barrels per stream day. Designed with considerable process flexibility it will be usable for a variety of purposes and at different rates. The M. W. Kellogg Company has the contract for construction.

The new, improved process applies for the first time to hydroforming the fluidized technique that has come into wide use in catalytic cracking. It results in higher liquid yields and higher octane numbers than are possible with the fixed-bed process.

The new fluid process permits wide variations in feed stock. In particular, it will upgrade naphthas of wide boiling range, including those of less than average naphthene content and blends containing up to 25 per cent of cracked stocks. Octane numbers 95 and upwards can be obtained.

AICE to Meet in New York

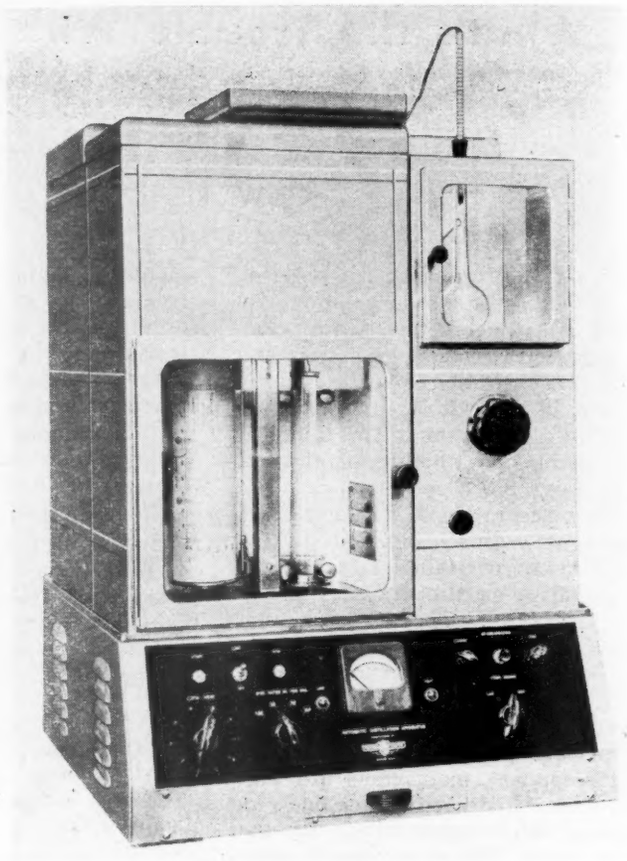
Rochester, New York, will be the scene of a national meeting of the American Institute of Chemical Engineers on September 17, 18, and 19. Headquarters will be established at the Sheraton Hotel and an attendance in excess of 600 is expected.

Three symposia will be included, on photography applications, plant maintenance, and education.

AN OLDTIME RECIPE FOR LONG-LIVED PIPE LINES

A recipe that waterworks and gas distribution engineers have used for over a century is: *specify cast iron pipe.* Refinery engineers have used it, too—with good success—for run-down, water and gasoline lines—for fire protection systems—salt water disposal—condenser and cooling coils. No other pipe, at reasonable first cost, offers comparable resistance to both interior and exterior corrosion. No other pipe, in its price range, is as economical in the end. Available with bell-and-spigot, plain end and flanged, or with standardized mechanical joints. Cast Iron Pipe Research Association, Thomas F. Wolfe, Engineer, 1015 Peoples Gas Bldg., Chicago 3, Illinois.

CAST IRON PIPE
FOR LONG LIFE AND ECONOMY



Precision-Shell automatic distillation apparatus

Automatic Distillation Apparatus

Precision Scientific Company, in cooperation with Shell Development Company, announces completion of an automatic distillation apparatus. The instrument will perform the following ASTM tests: D86, distillation of gasoline, naphtha, kerosine and similar petroleum products; D 268, sampling and testing of lacquer solvents and diluents; D 1078, distillation range of lacquer solvents and diluents; D 447, distillation of plant spray oils.

The apparatus has these features: Temperature and volume are plotted continuously; time is recorded every two minutes; heating (distillation) rate is controlled electronically; distillation rate can be varied from 4.5 cc per minute to 9.0 cc per minute.

New Catalytic Reforming Process

Houdry Process Corporation, pioneer in the field of catalytic cracking, announces "Houdriforming," a new continuous process for catalytically reforming low octane number naphthas to high octane number gasolines and for the production of benzene, toluene, and xylenes from petroleum. An important feature of the new process is the catalyst, which is a development of the Houdry laboratories at Linwood, Pennsylvania. The catalyst, which is fabricated from commercially available materials, has specific properties for the conversion of certain constituents of petroleum naphthas into benzene, toluene, and xylene. Furthermore, the low octane paraffin type constituents are converted to high octane gasoline. Another important feature of the process is that sulfur compounds are removed and do not otherwise affect the process. As a by-product, substantially pure hydrogen is produced in large amounts.

The catalyst, although capable of operating continuously for very long periods without regeneration, can be regenerated in place for operating flexibility and in the event that this becomes necessary for any reason such as plant failure.

—PERSONALS—

▸ **Carl J. Maki** has been appointed manager of the gas and gasoline department of Seaboard Oil Company of Delaware, Dallas, Texas. Maki was formerly in the gasoline department of Phillips Petroleum Company, Bartlesville, Oklahoma. He spent five years in Venezuela as superintendent of gas department for Mene Grande Oil Company and recently served as assistant chief of the gas branch in the production department of Gulf Oil Corporation, Pittsburgh, Pennsylvania. He is a graduate of the University of Minnesota.

R. E. Heithecker, formerly in the gas and gasoline department, will be in charge of the newly created reservoir engineering department in Dallas office of Seaboard Oil.

▸ **Harry L. Ericson** has been appointed chief chemist of Continental Carbon Company's new Amarillo, Texas, laboratory. Prior to going to Amarillo, Ericson had been associated with Witco Chemical Company's research laboratories in both New York and Chicago. He is a graduate of Northeastern University in Boston, Massachusetts.

T. A. Ruble has been named technical supervisor of Continental Carbon. He was formerly associated with the research department of Phillips Petroleum Company. A native of Indiana, Ruble received his formal education at Purdue University, where he received a degree in chemical engineering.

▸ **Charles A. Baer** is now associated with National Research Corporation as a project manager in its applied physics department. Baer received his B. S. in chemistry from Pennsylvania State in 1942 after which he was employed by Bausch & Lomb, Rochester, New York, until he joined National Research Corporation, where he will deal with high vacuum coating research and development problems.

▸ **Fred P. Lobban** has been appointed night supervisor of the process department in Deep Rock Oil Corporation's refinery at Cushing, Oklahoma. A native of New Jersey, Lobban received his B.S. degree in chemical engineering in 1940 and an M.S. degree in chemical engineering practice from M.I.T. in 1941. He was formerly with The Texas Company.

▸ **Thomas G. Delbridge** has been honored by the American Society for Testing Materials for his work in the field of engineering materials, and especially meritorious service to the organization over many years. Delbridge, now retired, was for many years manager of the research and development department of Atlantic Refining Company. His technical work in ASTM was concentrated principally in Committee D-2 on petroleum products and lubricants.

▸ **John M. Griffith** has been appointed engineer of research for The Asphalt Institute, succeeding **Prevost Hubbard,** retired, as head of the Institute laboratory and field research. Griffith received his B. S. degree from the University of Michigan. For the last 8 years he has been with the Flexible Pavement Branch of the Waterways Experiment Station at Vicksburg.

▸ **George E. Shaw,** who is associated with H. C. Scott and J. C. Riley, Jr., in Petro-Chemical Equipment Company, Inc., Houston, Texas, has recently completed a consulting engineering job commissioning a group of filters in the Abadan refinery of Anglo-Iranian Oil Company in Iran. During Shaw's stay at Abadan he and other engineers were evacuated to Basrah, Iraq, during the time riots broke out after Iran decided to expropriate the oil properties. They later returned to the refinery and completed the job before leaving for the States.

Left,
J. A. Rigby

Brooks Oil Company

Right,
H. W. Winkler

Dr. Nat C. Robertson

▸ **Dr. Nat C. Robertson** has been appointed director of the petrochemical research department of National Research Corporation. Dr. Robertson received his A. B. from Emory University in 1939 and his Ph. D. from Princeton University in 1942.

After a year with the Office of Scientific Research and Development he joined the staff of Standard Oil Development Company as a research chemist working on butadiene production and Fischer-Tropsch chemicals. He will supervise the petrochemical research and development program, which has been undertaken jointly by Electric Bond and Share Company, United Gas Corporation, and National Research Corporation.

▸ **Erich R. Westfield** has been assigned to the economic and correlation section of the research and development division, Houdry Process Corporation. Westfield is a graduate of Vanderbilt University and received his M. S. at Massachusetts Institute of Technology.

Gerald J. Orazem has also been assigned to the economic and correlation section of the research and development division. He recently received his M. S. degree at the University of Minnesota.

H. Harold Bulkowski has joined the development department and is assigned to the Atomic Energy Commission program. Formerly with Battelle Memorial Institute, Bulkowski is a graduate of Carnegie Institute of Technology and Ohio State University.

Dr. William E. Erner has joined the exploratory research group of the research and development division. He received his Ph. D. at the University of Notre Dame.

▸ **Joseph A. Rigby** has been named vice president in charge of engineering and sales of Brooks Oil Company. and **Henry W. Winkler** has been elected vice president in charge of research and laboratory control. Rigby, former manager of engineering and sales joined Brooks Oil in 1944. Winkler had been chief chemist of the company, before his recent election as vice president.

A quick quiz on Cooling Towers

Is your cooling tower meeting design specifications . . . giving trouble-free operation?

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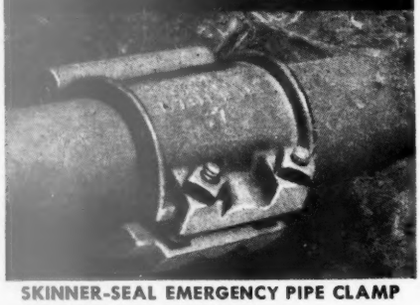

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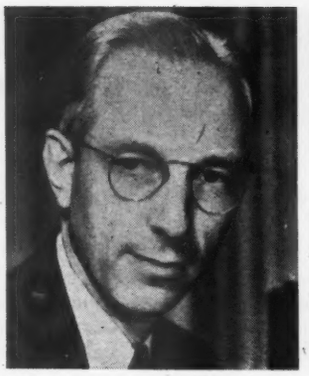
Kent H. Smith



Kelvin Smith

F. Alex Nason

Kent H. Smith, president of The Lubrizol Corporation since its establishment, has been made chairman of the board. He is succeeded as president by **Kelvin Smith,** vice president in charge of research and development.

F. Alex Nason was advanced to first vice president and director of marketing.

As chairman of the board Kent Smith will remain active in Lubrizol's business and will retain many of the duties and responsibilities he has had as president, and Kelvin Smith will continue to serve as director of research, it was announced. Both are graduates of Darthmouth College and later reeived engineering degrees at Case School of Applied Science, where their father, Dr. Albert W. Smith, was head of the chemistry department for many years.

All five of the men who founded Lubrizol in 1928 are still active in the business. They are Kent Smith, Kelvin Smith, Nason, Thomas W. James, and Vincent K. Smith.

Also re-elected to their positions as vice presidents are Thomas L. Holland, sales; Arthur O. Willey, engineering, and Clyde H. Britten, manufacturing. Russell J. Ferree continues as treasurer and Joseph Zlatoper as assistant treasurer. David K. Ford was re-elected secretary and general counsel and Charles L. Stone and Vincent K. Smith assistant secretaries.

Lubrizol's new plant at Houston, Texas is substantially complete.

Robert M. Chesney has been named manager of Deep Rock Oil Corporation's refinery at Cushing, Oklahoma. He will fill the position recently vacated when **K. O. Stowell** resigned.

Associated with the oil industry in various capacities since 1934, Chesney brings to Deep Rock wide experience in refinery management, processing, and petroleum chemistry. He received his B. S. degree in chemical engineering from the University of Delaware in 1932 and did additional study at Temple University.

He began his working career with the Socony-Vacuum Oil Company as chemist in 1934. In 1949 he became superintendent of Socony-Vacuum's second largest refinery which is situated at Paulsboro, New Jersey, and has a throughput of 70,00 bbl a day.

Dr. J. W. Bertetti has been transferred from the refinery of Pan-Am Southern Corporation, El Dorado, Arkansas, to the home office of that company at New Orleans, Louisiana. Dr. Bertetti is well-known in the fields of engineering and operation of refinery processes throughout the country.

Clement A. Damen has been appointed manager of Witco Chemical Company's Washington office. As Washington representative of Witco's defense products division, Damen will serve as contact for the sales and manufacturing divisions. He has been connected with the Witco sales organization for 25 years and, at one time, was manager of the Boston office.

Analyzing Crude Described

The method by which the Bureau of Mines has made thousands of analyses of hundreds of different crude oils on a comparable basis is described in detail in a bulletin released by Secretary of the Interior Oscar L. Chapman. The necessary equipment also is described and illustrated. The new bulletin describes the equipment and procedures used in the routine method of making crude oil analyses. It discusses distillation, sampling and sample handling, determinations of properties, and preparing the report of an analysis. It also includes an outline showing the procedure to be followed, step by step, with paragraph references to detailed discussions earlier in the publication.

Bureau of Mines Bulletin 490, "The Bureau of Mines Routine Method for the Analysis of Crude Petroleum, I. The Analytical Method," may be obtained from the Superintendent of Documents, United States Government Printing Office, Washington 25, D. C., for 50 cents a copy.

Cathodic Protection Series

The Correlating Committee on Cathodic Protection has issued the fourth and last of its series of bulletins on the protection of underground metals cathodically. Eleven nationwide organizations, including trade associations and private industries, sponsored the preparations of the bulletins, which were released through the American Petroleum Institute. The purpose of these publications is "to promote better understanding of cathodic protection and foster needed cooperation among operators of all types of buried structures in its beneficial application."

The last of the bulletins, that on "Cathodic Protection Technical Practices," is published in this issue of *The Petroleum Engineer*. Actually, it is numbered third in the series as originally announced, delay in preparation occasioning its completion and release subsequent to Bulletin 4. For the convenience of those who may now wish to assemble the entire series the following are the dates when they appeared in *The Petroleum Engineer:* Bulletin 1, "Management Information on Cathodic Protection," December, 1948; Bulletin 2, "Cathodic Protection Notification Procedures," February, 1950, and Bulletin 4, "Joint Cathodic Protection Systems," February, 1951.

As can be noted from the foregoing titles, the subject has been given a "well-rounded" coverage, and in order that the eleven organizations participating may be accorded deserved recognition, they are listed here: American Gas Association, American Petroleum Institute, American Public Works Association, American Water Works Association, Association of American Railroads, Bell System, Edison Electric Institute, International Municipal Signal Association, Inc., National Association of Corrosion Engineers, United States Independent Telephone Association, and Western Union Telegraph Company.

Progress Made in Safety

Concerted effort on the part of the gas industry to do something about a safety record, which a few years ago was highly unsatisfactory, is paying dividends. W. H. Adams, chairman of the Accident Prevention Committee of the American Gas Association, has announced the results of a study, which shows that during 1950 fatalities in the gas industry as a whole were reduced 35 per cent, and the accident frequency rate declined from 17.92 per million man-hours of work to 15.22, a reduction of 12 per cent. Considering gas pipe lines by themselves, the record is even better, the frequency rate being 14.90 and the severity rate 1.70.

Crude oil and products pipe lines show to better advantage in the statistical department, the two combined having a frequency rate of 10.60 and a severity rate of 0.84. In this instance the figures are from the American Petroleum Institute. Because of the more hazardous nature of the product handled by gas lines, however, a statistical comparison of this kind is not exactly just, nor is one necessary. Personnel of all types of pipe lines companies, almost without exception, are safety conscious in the extreme, from day laborer to top executive. Management well recognizes the importance of a good safety program, from a humanitarian as well as an economic viewpoint. Furthermore, so strongly has the matter been stressed that there are now few "old hands" on any job who are not safety minded. These are the basic things that make possible the record revealed by the above figures. —F. H. L.

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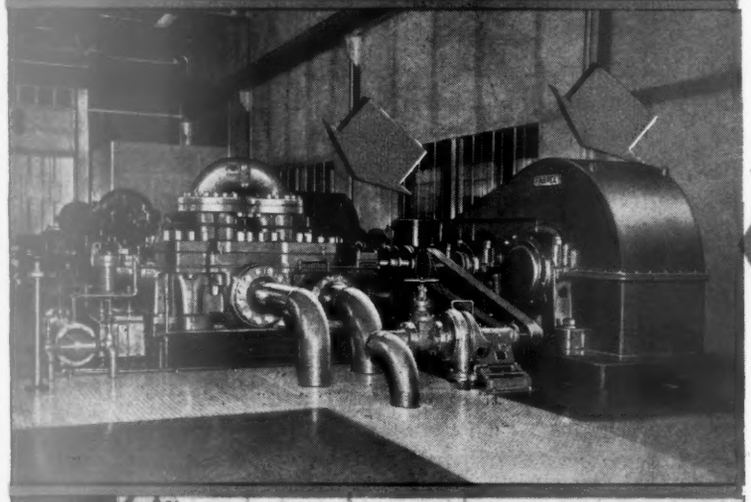

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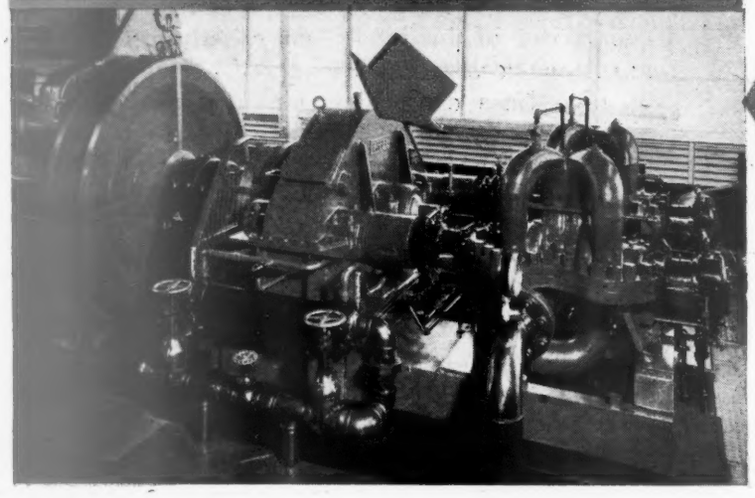

TWO-PINION UNIT
delivering 300 HP to each of two pumps from a single 600 HP engine.

Since 1932, Farrel has worked closely with the oil industry in developing speed increasers to meet normal as well as unusual requirements.

The remarkable performance record of the hundreds of these units now in service has established a virtual guarantee of satisfaction. All of them, including the first installed 19 years ago, are still operating successfully.

Farrel Type SI units were the first speed increasers to be placed on the market in a standard series. The modern SI line consists of 49 standard sizes with speed ratios ranging from 1:1 to 12:1. For higher ratios, units using two sets of gears are supplied with ratio range from 12:1 to 40:1. Two-pinion units, designed to transmit power from a single engine to two pumps, are also available.

For further information, send for a copy of Bulletin No. 448A. No cost or obligation.

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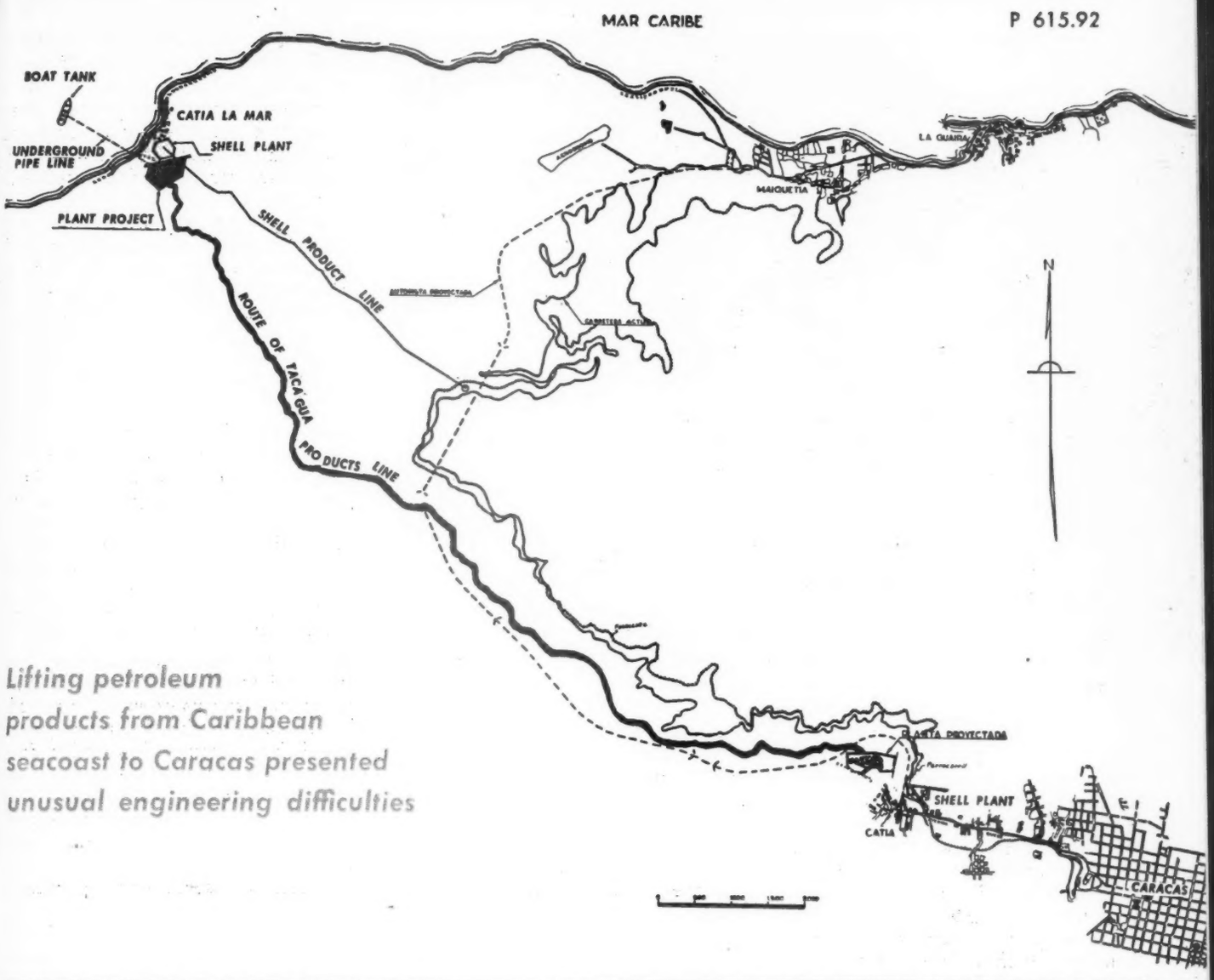


Lifting petroleum products from Caribbean seacoast to Caracas presented unusual engineering difficulties

Tacagua Products Pipe Line

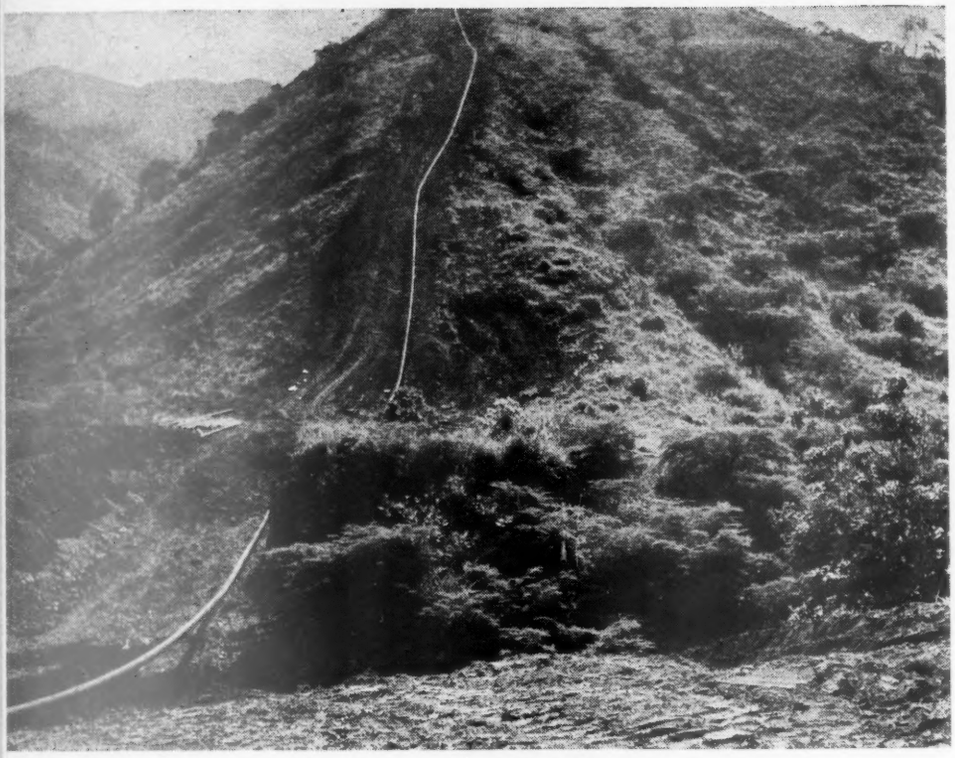
HARRY CHAPIN PLUMMER

MANY an anxious moment was experienced by the engineering force of the Creole Petroleum Corporation (Venezuelan operating affiiliate of the Standard Oil Company of New Jersey) that superintended the building of the Bs 14,000,000 (approximately $4,600,000) pipe line to accommodate the flow of petroleum products from tankers anchored off the Caribbean coast to Caracas, the capital city, only 16 km (9.94 miles) distant, but situated on the Llanuras 3600 ft above the level of the discharging tankers. Before the products, ranging from kerosine and gasoline to the denser diesel fuel, could reach the storage tanks in the highland metropolis, they would have to be pumped 780 meters (2559 ft) up one mountain ridge of the coastal spur of the Andes Venezuelan, down into a valley and up again, this time a "lift" of 980 meters (3216 ft), and finally dropping to the level of the city's precincts.

Obviously, the record-breaking haul up and over the mountains, and a host of other minor problems but indirectly related to altitude, presented engineering obstacles and difficulties of the first magnitude. Indeed, the descent from the mountain summits to the Llanuras was not without its drawbacks. The downward flow of products of such varying volume, weight, and density could not be left just to the principle of gravity, but had to be almost as minutely controlled as the upward drive by a pumping station having three centrifugal pumps capable of lifting 140,000 liters (890 bbl) an hour.

The basic motive for building the

EXCLUSIVE



Tacagua products line and main line right-of-way.

"Oleoducto de Tacagua", as the new pipe line is known in the vernacular of the homeland of Simón Bolívar, was the inordinately growing demand for petroleum products in and around Caracas. The rapid growth of the city as an industrial center, with each new industrial plant requiring fuel other than the prohibitively expensive coal briquets imported from overseas; the sudden "switch" of Caraqueño householders from charcoal to kerosine as a cooking, and occasional heating, medium, and the rapid advance in motor car, truck, and tractor ownership and operation had created a top-heavy market.

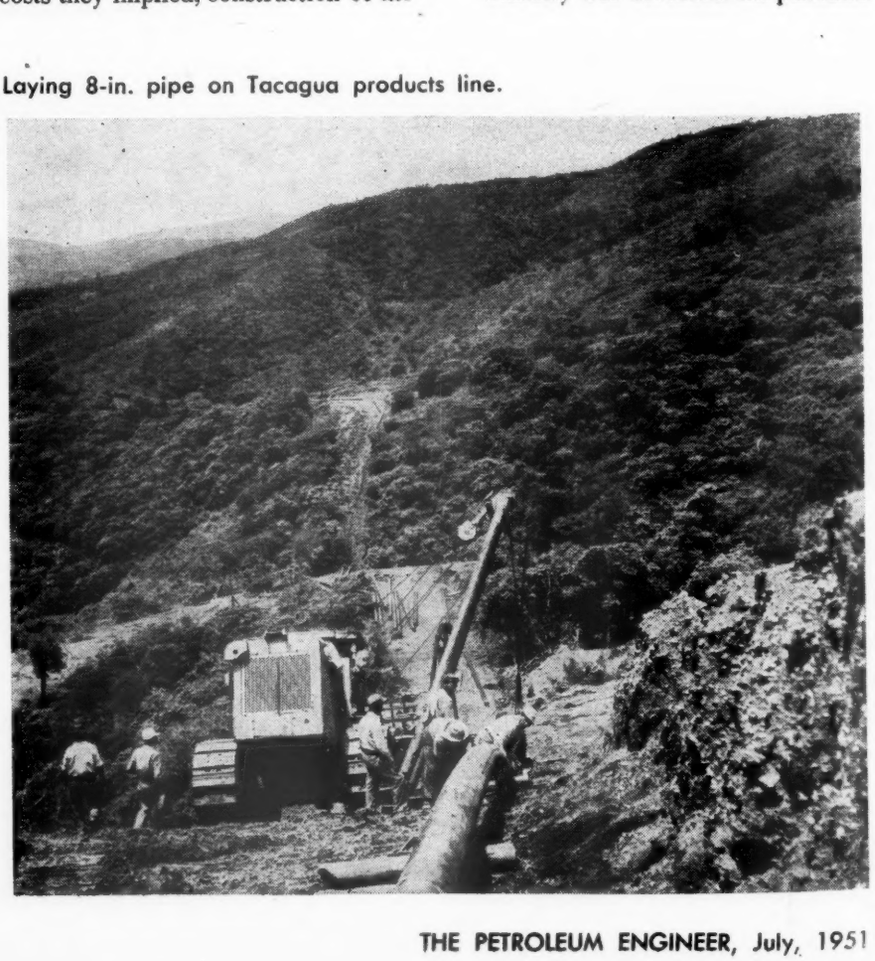
The Creole Petroleum Corporation long ago decided upon a policy of meeting that mounting demand and seeing to it that the metropolitan area lacked none of the products refined by that organization from the crude so abundantly produced by the country's wells. Even during the difficult days of World War II, when tankers bringing the precious fluid from the western and eastern reaches of the Republic were torpedoed off the neighboring coast, the people of Caracas and other Venezuelan cities had gasoline for their cars. In the postwar years to satisfy the Gargantuan calls for more "petrol", the company established a tanker-car service on the erstwhile British (now state-owned and operated) Caracas-La Guaira Railway, which, in forced runs, made 100 round trips daily between the chief seaport of the nation and the highland capital. Even that volume of supply soon became insufficient. So despite the overwhelming engineering difficulties entailed and the staggering costs they implied, construction of the pipe line was announced. Likewise, confronted with the supply dilemma at Caracas and its environs, the Shell-Caribbean directorate pooled that company's resources with those of Creole in the financing of the project.

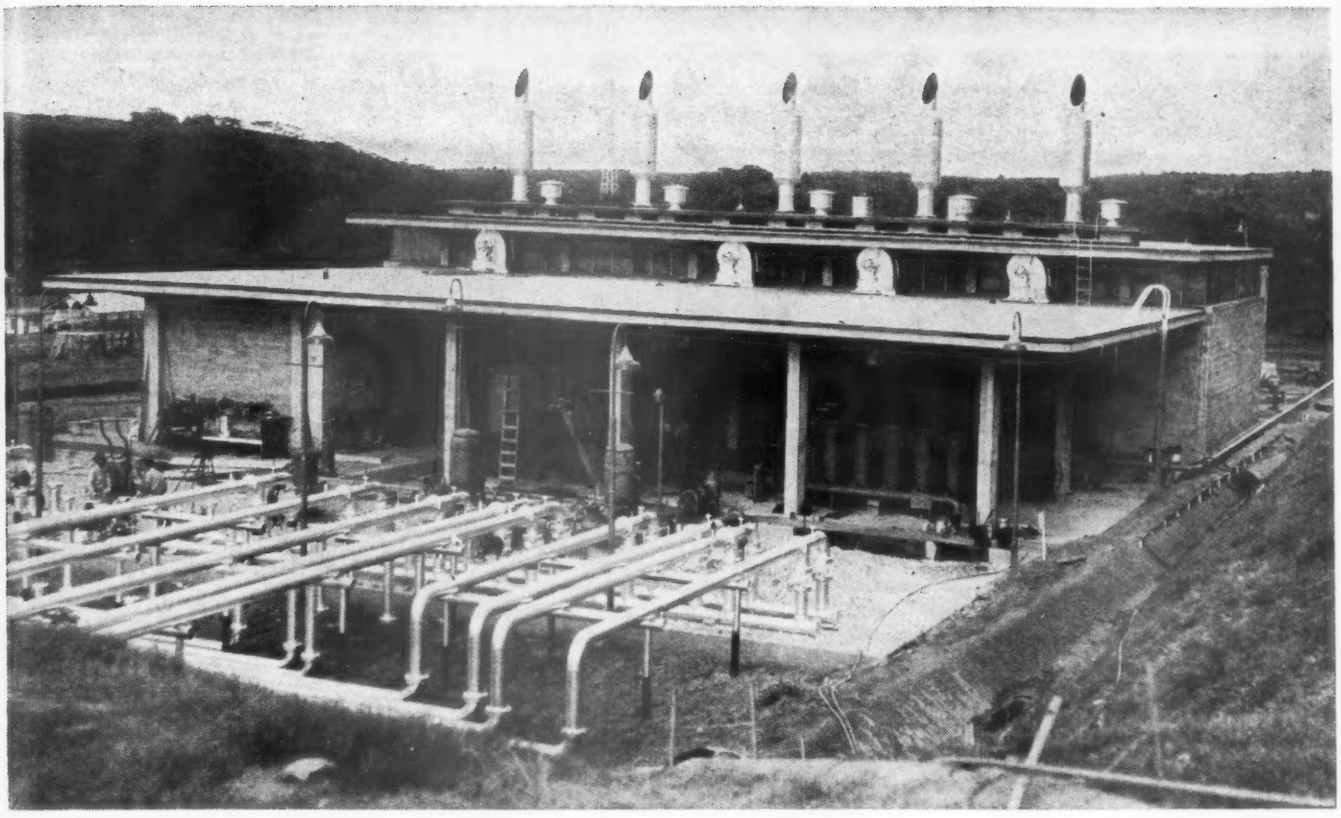
First and foremost of the obstacles, of course, was getting the oil over the mountain range that forms a natural barrier between the Caribbean and the fertile highland plain upon which Caracas is situated. Apart from the unprecedented formidable obstacles to be overcome, there was the question: Could almost 1000 tons of steel of exacting specifications be obtained?

When, for the first time, engineers surveyed the future route of the Tacagua pipe line, they realized they were projecting an engineering hazard having no precedent among similar structures. The abrupt changes in terrain over which the pipe must be laid, the steep incline of the slopes, and the threatening scarcity of the proper pipe in the post-war period were factors auguring ill for the success of the operation. Besides, it was calculated that pipe of 8 in. diameter would be one of the most expensive ever contracted for because of the difficulties mentioned. Even though they had a distance of but 16 km (9.94 miles) to consider, engineers figured that the line pipe alone, quite apart from the task of laying it, would almost exhaust the budget.

Priority was accorded the purchase

Laying 8-in. pipe on Tacagua products line.





General view of main manifold and pump station at the Catia La Mar.

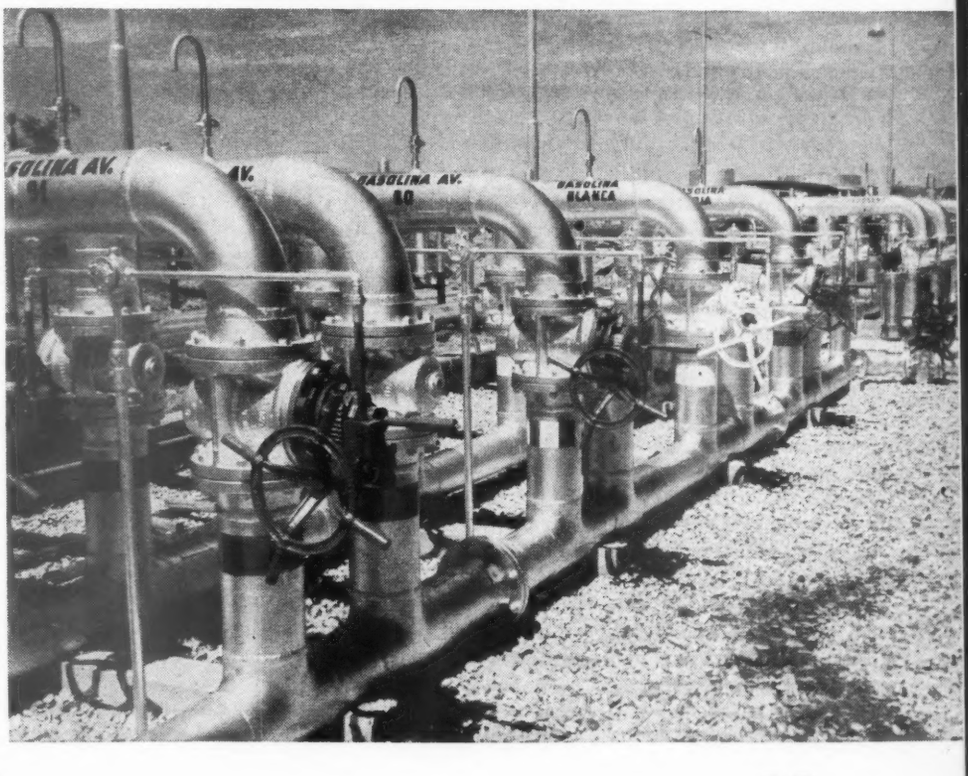
of materials, especially steel, for the enterprise. The scarcity of all building material in the postwar era made it imperative that such materials be bought whenever and wherever possible. Some machinery had been landed in 1947 at La Guaira, the chief seaport of the Republic, 6 miles by direct line but 22 to 25 miles by rail and highway, respectively, from Caracas, and other machinery arrived in 1950.

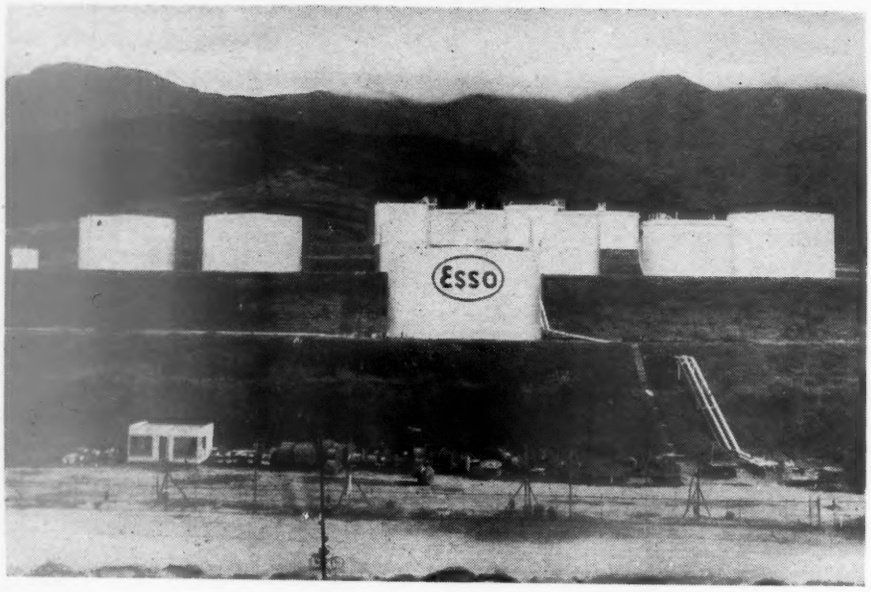
Before beginning the extraordinary task, measures had to be taken to procure the right-of-way. Owners of cacao, cocoanut, and banana plantations on the lower levels, and of coffee and citrus groves in the highlands, had to be compensated for the transit permission. Careful preliminary surveys and investigation were undertaken to obtain the best possible route to cross the cavernous depths of dry stream beds, which become torrential streams in the rainy season, and the crooked and twisted turns of the valley. Eventually the right-of-way was worked out.

It then became apparent that, due to revisions imposed by the construction of the super-highway between Caracas and La Guaira in the future, it would be necessary to depart from the right-of-way as established. Again personnel was sent into the valley to develop the new route.

One important development that had to be taken into consideration in the selection of the route was the frequency with which corrosive soils were encountered in the valley. The major part of the pipe, of course, was to be laid on top of the ground. To have attempted to bury it would have occasioned prohibitive expense. In many instances, along the valley, electric current in the soil eventually would have corroded the pipe causing leaks. A scientific explanation of the electrolytic condition of the soil in the

Close-up of main manifold at pump station shown above.





At one end of the pipe line are Creole Petroleum Corporation's tanks situated on the hillside at Catia La Mar.

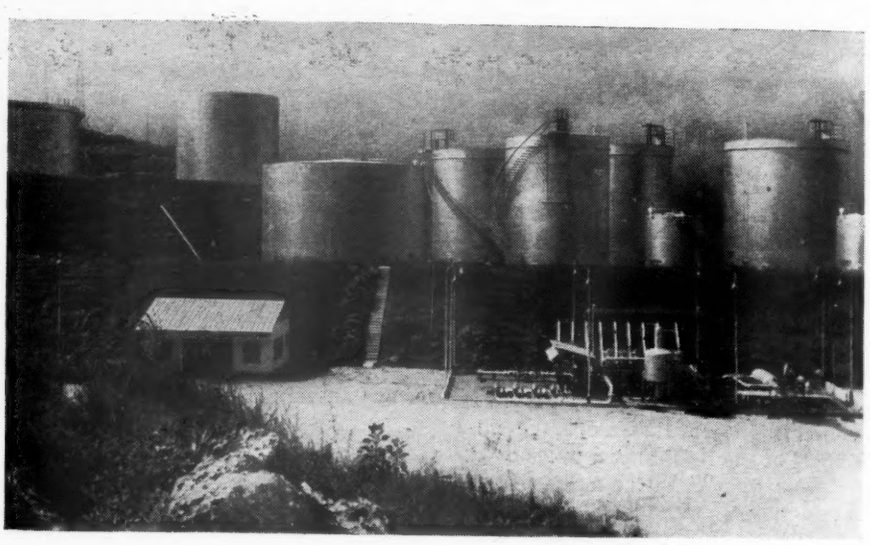
Below is the terminal of the products line in Nueva Caracas and a portion of Creole's tank farm at this end of the line.

Tacagua Valley has not thus far been forthcoming, but some engineers account for it by a "return drainage to the sea of the electric current that is the motive-power of the Caracas-La Guaira Railway." So tests were made to determine where the currents were produced with the greatest frequency and, if possible, these electrically charged areas would be avoided.

In constructing the line, one of the greatest problems was caused by the pipe crawling due to expansion and contraction brought about by the heat of the sun in daytime and the coolness of the nights. It was feared that the great weight of the pipe, especially when filled with oil, might cause the welded points to break, allowing the pipe to crash down the mountainside. The problem was solved by installing a series of anchors embedded in concrete.

Finally, at the end of November last, the line was completed. At Catia la Mar, the unloading port, Creole had constructed 10 storage tanks with a capacity of 57,000,000 liters (358,557 bbl). At Nueva Caracas, the metropolitan end of the line, situated on the ridge of the mountains, there were 10 more tanks, accommodating 16,000,000 liters (100,648 bbl). These, together with the nearby tanks of the Shell-Caribbean, accumulated supplies sufficient to fill the needs of Caracas for several days of constant use.

Now came the final "showdown". Diesel fuel was pumped landward from a tanker anchored just off the shore at Catia and into one of the storage tanks. That would be the heaviest product to be sent up the mountainside; would be the "acid test". Petroleum flowed into the pipe and two giant pumps began to pulsate.



Twelve hundred barrels of diesel fuel had begun the ascent of the mountain. Then the first "pig" was inserted in the pipe.

Three hours and 20 minutes after the first barrel had been emptied in Catia la Mar, a significant message reached the Nueva Caracas terminal over the radiophone: "Diesel oil now moving out, very dirty". Dirty because of the dirt, scale, and other debris that had accumulated inside the pipe during construction. At the terminal at Catia la Mar, officials awaited in vain a second message that would report the arrival of the "pig". As was later learned, it had become stuck in the pipe at some point on the mountain stretch. Gloom descended over the little waiting group, for to locate the "pig" might occasion a long and costly delay.

Slowly the line pressure was built up until it reached 1875 psi. A greater pressure could not be exerted without danger of bursting the pipe. For several minutes, which seemed eternity to those waiting at the other end, the mountain top station, the dramatic struggle between the stuck "pig" and the massing diesel oil continued in the dark recesses of the pipe. Then, in one sudden spurt, the "pig" gave way and began to move forward a mass of dirt, stones, and other objects. Behind the "pig" the petroleum flowed, and soon it was safe in the tanks at Neuva Caracas.

When the second "pig" made its journey through the steeply inclined pipe the following day and arrived "without incident" at Nueva Caracas, bringing behind it a flood of kerosine, the "Oleoducto de Tacagua" was declared officially "ready to begin routine operation". Since that time Esso and Shell petroleum products have moved obediently up and over the mountain at all hours of the day.

* * *

P 615.635.4

Cathodic Protection Technical Practices

Application of cathodic protection and mitigation of electrolytic corrosion caused by stray current from cathodic protection systems

BULLETIN No. I, "Management Information," prepared by Correlating Committee on Cathodic Protection committee, describes cathodic protection in non-technical terms. It indicates generally how this beneficial technique can be applied, and the nature of certain interference problems to be solved cooperatively. Bulletins Nos. 2, "Notification Procedures," and 4, "Joint Cathodic Protection Systems," further discuss these problems and indicate procedures for their solution. This Bulletin, No. 3, deals with their technical aspects, and prevalent good practices.

Corrosion of metal is an electrochemical action. Where metals are in contact with an electrolyte, they will corrode if electric current[1] flows from them into the electrolyte. Conversely, they will not corrode if the current flow is stopped or reversed in direction. A metallic structure in contact with soil is such a metal in an electrolyte. If a stray electric current flows from the structure into the soil, the metal will corrode by electrolytic action called "electrolysis." If the metal is corroded by "concentration-cell" action, i.e., by selective chemical attack on a single metal structure contacting non-homogeneous soil, such will generate a current that will flow from portions of the structure into the soil. This latter action occurs to some extent along all buried structures traversing adjacent soil beds of different chemical properties.

In either type of corrosion, the outward flow of current from metal into soil indicates that the metal surface is discharging positive ions and is therefore "anodic." Experience proves that the attendant corrosion, if electrolytic, can be mitigated or stopped most practicably by channeling the return of current from the structure through metallic conductors leading toward the current source. If the corrosion is of the concentration-cell type, or due to any causes other than stray currents, it can be stopped or mitigated by (1) stopping the flow of current by completely insulating or "coating" the structure, or (2) reversing the direction of current flow to make the structure "cathodic." This latter technique is called "cathodic protection."

This bulletin describes briefly the fundamentals of the application of such cathodic protection, and the mitigation of any electrolytic corrosion that may be caused by stray current from cathodic protection systems. It is not intended to deal with the mitigation of electrolysis caused by stray current from other sources.

In metropolitan areas where congested interlacings of various types of buried structure system exist, the problems of the mitigation of both types of corrosion are too complex to be dealt with in a bulletin of this general nature. Many of them are described in the articles listed in the bibliography appended and in the more extensive bibliography cited in last paragraph of Bulletin 3. The solution of such problems is best handled by local "electrolysis" committees composed of engineers who represent the several structure owners concerned. A list of such committees is given in an Appendix of Bulletin 2.

Cathodic protection of underground metal structures has been used for more than 20 years, and it is of proved merit, but the methods followed in its application are still being developed and differ in detail among individual engineers. Extensive correlations of experience aimed to harmonize such differences are being actively undertaken by Technical Practices Committees[2] of the National Association of Corrosion Engineers. Significant results should attend their work. This bulletin is confined to a general presentation of technical practices now in use.

In applying cathodic protection, the following questions arise:

1. How much protective current is required?
2. Where should the current supply be situated?
3. What type of power supply is best suited to the particular job?
4. What kind of ground-bed should be used?
5. Are the protective currents likely to stray to other structures and cause interference, or electrolysis? If so, what is the best all-around solution of the problem?

These questions are dealt with in the following sections.

This is Bulletin 3 of the series on cathodic protection prepared by the Correlating Committee on Cathodic Protection, sponsored by 11 organizations. Bulletin 1, "Management Information on Cathodic Protection," was published in *The Petroleum Engineer*, December, 1948; Bulletin 2, "Cathodic Protection Notification Procedures," February 1950, and Bulletin 4, "Joint Cathodic Protection Systems," February 1951.

Current Required

In practice, cathodic protection of a buried metal structure against corrosion consists of forcing protective currents through the surrounding electrolyte, usually soil or water, into the structure to be protected in sufficient density to counteract and prevent any outward flow from the structure of stray currents or the natural currents that are always associated with the corrosion process. These applied protective counter-currents serve to maintain the structure surface in a cathodic state. To determine in a given case how much protective current is required for full protection, it would appear logical first to measure the densities of existing corrosion currents, and then to estimate the density of the protective current necessary to suppress them.

But such direct measurement of the corrosion currents is impracticable. The locations of corrosive spots are never accurately known in advance and, if they were, the work required to measure their individual currents would be prohibitive. Also, the first application of protective currents will alter local conditions so that the current density required initially to stop corrosion may be greater than that required later to maintain effective protection.

[1] The currents dealt with in this bulletin are "direct" or unidirectional.

[2] A list of such committees dealing with problems relating to cathodic protection is given in Appendix A.

Thus corrosion engineers have developed more practical test methods and criteria aiming at:

1. A minimum of field testing consistent with reliability.
2. Suitable and adequate field testing equipment.
3. Test data of a type that can be readily interpreted in terms of protection.

Most engineers concur that the most practical method of determining protective current requirements is to apply such a current to the structure on a trial basis, using portable power supplies and temporarily-installed anodes. The current flow can be adjusted until relatively simple field measurements indicate that cathodic protection has been established on the structure sufficient to prevent further corrosion. (Suitable power-supplies and anodes are discussed in subsequent sections.)

The adequacy of protection is best determined by measuring the potential it establishes between the structure and the soil under various rates of current flow. Such potentials can be measured by use of a voltmeter or potentiometer equipped with insulated lead-wires, one attached to a soil-contact reference electrode (or half-cell) and the other to suitable test leads or a sharp prod capable of making good electrical contact with the structural metal. The last condition is especially important, because many erroneous or misleading voltmeter readings may occur if an IR drop or galvanic voltage is caused by any mill scale, corrosion products or pipe coating that may remain between the contact prod and the bare structure metal. When prodding soft metals, due care must be taken not to puncture them.

The voltmeter should have an internal resistance at least 50 times that of the remainder of the circuit, this to minimize circuit resistance errors to a practical degree. Some engineers prefer to use potentiometers because of their infinite resistance characteristics and reliability. For making the voltmeter contact to the soil, a suitable non-polarizing reference electrode (or half-cell) is used. For testing on steel or black-iron structures, generally a copper sulphate half-cell is used. For testing on lead cable-sheaths, a lead chloride half-cell may be used. Some cable engineers, however, prefer to use an electrode made of the same metal as the structure.

The structure- to-soil potentials thus indicated by the voltmeter will differ according to the condition of the structure under test and on the location and type of reference electrode used. Potentials measured with one type of electrode can be expressed in terms of others, however, by merely adding or subtracting known conversion factors. If the electrode used is reliable, its type has little bearing on the final answer. The half-cell electrodes are generally preferred because their potentials are more easily reproduced and are less affected by environmental factors.

Based on such potential measurements, certain widely accepted practical criteria, indices or "yard-sticks" of adequate cathodic protection have been developed. Using the half-cell reference electrodes, experience has shown that adequate protection of steel or black iron pipes usually is obtained if their potential is reduced by the protective current to measure about minus 0.85 volt with respect to a copper sulfate half-cell in contact with the soil.[3] For galvanized pipe, a potential with respect to a copper sulfate half-cell of about minus 1.10 volts is required for protection. Adequate protection of lead cable-sheaths usually is obtained if their potential is reduced by the protective current to about minus 0.05 with respect to a lead chloride half-cell.

Discretion must be exercised in employing any general-purpose yard-stick, since higher potentials may be required in environments such as cinder-fills or where bacterial corrosion is present. Only further testing or experience can indicate when protection is obtained under such conditions. Caution must be exercised when applying the higher criteria for steel and black-iron structures in the vicinity of other underground metal structures—particularly in congested metropolitan areas.

Using a reference electrode made of the same material as the structure is not normal practice for tests on steel or black iron structures. This is because errors can occur, due to polarization and local oxidation effects, which are difficult to detect — especially by one unaccustomed to the use of such electrodes; thus their use is not recommended. On the other hand, underground cable engineers usually prefer to use a piece of lead-cable-sheath for the reference electrode. Lead cable-sheaths are considered to be protected if their indicated potential to soil with such an electrode is slightly negative.

Protective current flowing from the soil to a structure causes potential gradients which depend on the electrode location, the soil resistance, and the amount of current flow. The reference electrode used for measuements along a well-coated pipe line or cable can be located either over or near the structure without introducing appreciable error. For measurements along a poorly-coated or bare structure, some engineers prefer to locate the electrode a distance away from the structure equal to the depth of its burial. Others favor placing the electrode at a distance where further removal causes no change in potential readings. The positioning of such electrodes is best determined by experience and, in general, will vary with the types of climate and soils. A special method, called the "null method," has been devised that aims to minimize the errors of electrode positioning. Engineers seeking to use this alternative method can find it explained in corrosion literature.[4]

Another completely different method sometimes used is to calculate the amount of protective current required on the basis of establishing a minimum adequate current density over the entire structure. The density required for protection of steel or black-iron structures in soils varies widely and is affected by soil type, resistivity, moisture, aeration, etc. Densities considered adequate for protection of these structures range from 0.50 to 20.0 milliamperes per square foot depending on whether the soil is mild or highly corrosive.[5] Such calculations sometimes are used to check the results obtained by the potential test methods above described. Also, they may be used for estimating the size of power supply required for the potential test methods.

All the above indices are used to determine when sufficient current has been applied; however, use of larger-than-necessary currents adversely affects the economy of an installation. Such a practice increases the first cost of power-supply equipment and anodes or ground-beds, as well as the annual costs of current and of anode replacements. Also, it increases any undesirable effects the currents may have on neighboring structures.[6]

In using any of these indices of current adequacy, it must be borne in mind that they apply only to condi-

[3]Calculated counter-potentials required to stop corrosion of iron in several different common chemical solutions averages 0.283 volt ranging from 0.272 to 0.291 volt. Laboratory tests have been in close agreement with these. The potential between iron or low carbon steel (0.15 carbon content or less) in a solution and a copper sulphate half-cell contacting this solution has been determined as 0.54 volt; thus the potentials required between the above metals and half-cell to obtain protection equal or exceeding the calculated protective voltage plus the half-cell voltage, viz, 0.812 to 0.831. A minimum potential of 0.85 volt which allows a factor of safety is commonly accepted as sufficient to protect most iron or steel structures underground.

[4]See bibliography article No. 18.
[5]See bibliography article Nos. 14, 15, etc.
[6]See bibliography article No. 48a.

tions desired on the structure to be protected. The satisfactory protection of one structure may in fact definitely harm adjacent ones, particularly lead cable-sheaths adjacent to steel pipe lines.

Current Supply Points

The locations at which protective current should be applied to a structure, as well as the amount of current required, may be determined by use of portable power supplies connected between the structure and temporary anodes. Batteries or portable motor generator sets can be used. The resistance to soil of temporarily installed anodes is usually quite high, thus a relatively high voltage must be used to obtain currents large enough to produce reliable structure-to-soil potential readings. These readings should be taken along the structure at points progressively away from the power supply connection, this to insure that the current is adequate—but not excessively so — to produce the desired minimum potential or potential change all along the structure.

Where a long line is to be protected, the data obtained from a single temporary power supply and anode may be used to estimate the effects of additional current sources at regular intervals along the line. In such estimations, it is assumed that the change in the structure-to-soil potential produced by the test current is directly proportional to it. Such is not always true, however, because the current collected per square foot of area is not directly proportional to the structure-to-earth potential. Also, the continued passage of current to the structure increases its surface polarization and acts to extend the area of the structure effectively protected.

Depending on conditions, it may take only minutes, or it may take several weeks, for structure-to-soil potentials to become stable. Short-time tests are liable to indicate excessive current needs, and this must be taken into account in the final system design — largely on the basis of experience. In some cases, the temporary equipment can be left in operation long enough to establish stable conditions and thus most accurately indicate the required current.

The choice of current supply locations depends to a large extent on the type of permanent power supply suited to the job. If a central station power source is to be used, sacrifice of some engineering nicety may be warranted to reduce the cost of service-line extensions. Local soil conditions also may influence the choice. A low-resistance ground reduces the voltage required to circulate the protective current, and correspondingly reduces costs of installed equipment as well as the recurring power bills, thus it is important to provide suitable low-resistance ground-beds. Usually, earth with a low resistivity serves best for this purpose. Because some locations along a structure insure better grounds than elsewhere, this factor is coordinated with the others.

The locations of supply points affect the tendency of cathodic current to stray into nearby structures. It is obviously desirable to select locations that minimize adverse effects, which may not be confined to electrolysis. Care should be taken to avoid locations near railroad tracks employing signal systems that might be falsely operated by direct current entering the rails. The likelihood of any adverse effects should be determined by cooperative tests made with the engineers of the operator of the railroad or other structures involved.

Available Current Sources

Sources of direct-current power considered most practical for cathodic protection are:

A. External power sources:
   1. A-c d-c rectifiers.
   2. D-c generators driven by various types of prime movers.

B. Galvanic anodes. (Magnesium, zinc or aluminum.)

Where large amounts of current per location are required, it is generally more economical to use external power sources, although in some cases the use of a large group of galvanic anodes may be preferable.

Service from a-c power, if available, is preferred as a prime source by most engineers. In some cases, private power lines have been built along a pipe line for the sole purpose of supplying a number of a-c d-c rectifiers. Most of the rectifiers in use are the copper oxide or selenium types, connected to 60-cycle a-c power lines. Copper oxide and selenium rectifiers differ in their characteristics, but both types are satisfactory for cathodic protection service. Both provide an efficient, low-cost, and low-maintenance source of direct current. A comparatively few vacuum-tube rectifiers are in use, probably because they become efficient only at unnecessarily high output voltages, and their current output is smaller than for the copper oxide or selenium types of comparable dimensions. Where an alternating-current power supply is available, rectifiers are much more satisfactory than a-c d-c motor generator sets.

Where a substantial current is required and an alternating-current supply is not economically available, engine-driven generator sets may be used. Wind-driven generators, being dependent on the weather, have only a limited field of use, but their lack of reliability can to some extent be compensated for by the addition of storage batteries or galvanic anodes. There are a few successful installations of this kind.

Galvanic anodes are unique in that they are self-powered. Together with the structure and the soil, they create gigantic "dry-cells." They can produce efficiently only a few hundred milliamperes per anode, but on coated structures or on plant of limited extent, this may provide adequate protection. It is often practical to install galvanic anodes, singly or in groups, at frequent intervals along a long line, and thus obtain the condition that might be obtained by rectifier-type supplies at wider spacings. For galvanic anodes, magnesium and zinc are now favored by corrosion engineers. A new type of magnesium ribbon can be laid parallel to the line and thereby provide a continuously-distributed anode. Aluminum so far has not been extensively used or shown to have suitable characteristics for this work. The characteristics of all three types are being studied by a committee of the National Association of Corrosion Engineers.[7]

The most appropriate metal for, and disposition of, galvanic anodes for protection in any given case will depend upon the structure metal and the soil conditions. Other conditions being identical, the current output of a galvanic anode depends on the effective electromotive potential of the anode metal relative to that of the structure metal.

Open circuit potentials between properly installed galvanic anodes and reference half-cells contacting adjacent soil are relatively constant, that of magnesium relative to copper sulphate being about 1.50 volts and that of zinc to the same reference being about 1.0 volt. It is often impossible, however, to predict accurately the effective potential of a galvanic anode relative to an undisturbed buried structure, for two reasons.

First, the theoretical relative potentials calculated from the values listed in "electromotive series" tables of handbooks are seldom realized when the two metals are placed in soil or water. Second, the innumerable and often wide variations of undis-

[7]See bibliography item No. 54.

turbed structure surface and burial environment cause corresponding and unpredictable effects on these potentials. Thus only local experience or testing can determine with reasonable accuracy what effective open-circuit anode-to-structure potential may be realized in a particular installation.

Anodes and Ground-Beds

The design of a good ground for the current supply depends on soil conditions and the amount of protective current required.[8] The term "ground-bed" usually refers to a group of anodes interconnected and operated as a unit. The terms "anode" and "ground-bed" are used herein somewhat synonymously. In cathodic protection the corrosion is transferred in effect from the structure to the buried anode, thus the latter in time will be consumed and need to be replaced.

Where the soil resistivity is low and the current requirements small, steel rods driven vertically into the earth can be used. Often junk iron or steel pipe or old rails are so used. These are consumed at a rapid rate, but, if easily replaced, may be more economical than a longer-lasting arrangement of greater cost. The use of finely-divided coke or "coke-breeze" surrounding the buried steel has been found, in some instances, to increase its life. Carbon and graphite rods also make suitable ground anodes. Some difficulty has been experienced in obtaining economical life from carbon rods in salt environments, but specially-treated graphite rods have been buried in salt-impregnated earth and directly in sea water with favorable results.

The physical size of the anode installation usually is designed to insure a reasonably long service life, and to provide a resistance low enough to minimize power requirements. For large installations where costs are substantial, an analysis comparing the annual costs of grounds of various resistances versus their power requirements will indicate the optimum combinations. Formulas for estimating the resistance to ground of various shapes, sizes and arrangements of ground electrodes are available.[9]

The wires connecting the external power source and the anode or ground-bed will be corroded unless they are insulated along their length and at their connection to the anode or ground-bed. This is not the case with galvanic anodes, since the wire also is cathodically protected and need be only mechanically strong. Insulating the wire will serve to prevent waste of protective current, however.

Cathodic Protection Coordination

Cathodic protection systems properly engineered with full cooperation between the owners of the protected and the adjacent structures should cause no damage to the latter. In fact, such cathodic installation frequently will provide a small measure of protection to the other structures. This ideal situation can be obtained only through such cooperation, however. Its need is discussed in Bulletin 1, and it is implemented in Bulletin 2, which outlines procedures for the notification of neighbors where cathodic protection is contemplated. Cathodic protection is an invaluable tool of industry for the mitigation of corrosion. Thus any arbitrary restriction of its use should be avoided because such restrictions would impair the overall industry economy and retard the desirable widespread use of cathodic protection.

When cathodic protection is applied to a buried structure, some of the protective current will unavoidably stray through the soil to other nearby structures. After traversing these other structures, the current will return in some way to the protected structure. If, in this return circuit, the current leaves the unprotected structure through the surrounding soil or water, then that portion of the structure is made anodic and may corrode due to electrolytic action. Under some circumstances such stray-current interference may become serious.

As has been indicated in Bulletin 2, the extent of the stray current problem depends in general upon three factors, which are (a) the "influence" of the particular protection installation, (b) the "susceptiveness" of the affected structure, and (c) the "coupling" between the protected and affected structures. The first is to a large extent under the control of the designer of the cathodic system. The second and third are inherent in the structures and their environments, but an understanding of them will assist the designer of the cathodic protection installation to estimate the probable extent of the stray current and foresee what corrective measures may be needed to eliminate damage to other structures. These factors are discussed in more detail below:

A. Influence. "Influence," as herein used, is the inherent tendency of a cathodic protection installation to produce "stray currents." It depends upon the amount of current used, the location of the anodes or ground-beds, their configuration and resistance to earth, and the type of structure (i.e., bare, poorly-coated or well-coated) being protected. For any fixed anode arrangement, and type of structure, and soil resistivity, the influence is directly proportional to the current. This points up the costliness of using more current than necessary to achieve protection. To satisfactorily reduce undesirable effects on neighboring plant, it sometimes may be necessary to actually use less current than is needed for complete protection.

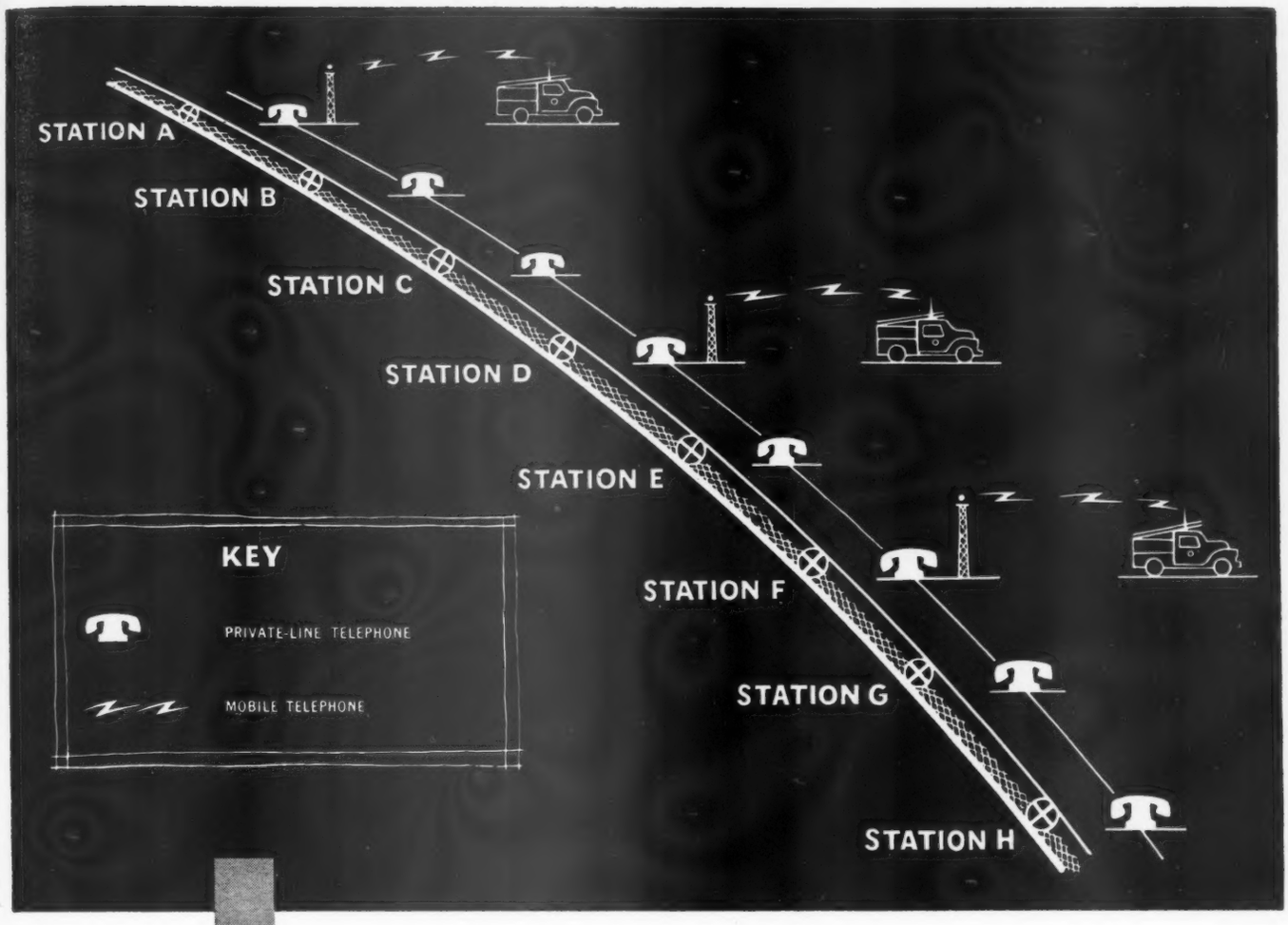
Most of the protective current enters a bare line relatively close to the anode. Thus the stray problem with protected bare lines is usually one of relatively high intensity over a limited area. A pipe line even poorly coated requires much less current for protection than an uncoated one. With protected well-coated pipe lines the intensity may be lower, but the area of possible stray current effects may be greater. If a line is to be protected in place — or "as is" — there is no opportunity to alter the coating conditions.

A large current may be applied at one location with the objective of having it "reach out" to protect points some distance away; however, to minimize the influence, several smaller currents may be applied at intervals along the line to give more uniform coverage. For example, galvanic anodes supplying small currents at frequent intervals along a line are unlikely to create serious stray-current problems. Also, frequently the sum of these individual currents adequate for protection is smaller than the required "single-point" current.

The location of the anode or ground-bed with respect to the protected structure has a marked bearing on the influence, depending on whether or not the line is coated or bare. The closer the anode is to a protected bare structure, the smaller will be the influence, and vice versa. Also, as the distance between the anode and the protected bare structure is increased, the greater is the chance that nearby unprotected structures will be included in the circuit.

With coated lines, the distance to the anode is not so important, except as it affects the proximity of the anode to the unprotected structures. In general, the anode should be placed so as not to include an unprotected structure between it and the protected one, i.e., the protected stucture should lie between an unprotected structure and the anode.

[8]See bibliography item No. 56.
[9]See bibliography article No. 39.



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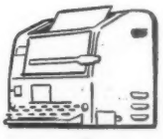
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If two structures are more or less parallel, or if they cross and form some reasonably symmetrical arrangement, it is possible to so locate an anode for the structure to be protected that it will have a minimum effect on the other. In practice, however, such uniformity or symmetry is usually lacking; or the required location of the anode or ground-bed, when found, will be impractical for other reasons. Every means of reducing the influence of an installation merits consideration, however.

B. Susceptiveness. "Susceptiveness," as herein used, is the inherent ability of an unprotected structure to pick up stray current and discharge it in a manner likely to cause corrosion. The most susceptive structure is an uncoated one, and the least susceptive is a structure with a highly-insulative-coating. Between these extremes are pipe lines with leaky coatings and bare cables in tile or other semi-insulative conduits. A pipe line with a poor coating, as long as such coating is fairly uniform, is much less susceptive than a bare structure. Poor coatings do not prevent the pick-up and discharge of current, but they distribute it and reduce the chance of concentrated action. In view of the protection from stray currents as well as from natural corrosion to be afforded by coating, such should be considered on new structures to be laid in areas where cathodic protection system are likely to be in operation.

C. Coupling. "Coupling," as herein used, is the change in potential of a particular unprotected structure when protective current is applied to a nearby structure. Assuming a constant influence and susceptiveness, the tendency of a cathodically protected structure and its anode to cause the flow of current in a nearby structure depends upon the earth resistivity and the physical separation between the structures. The closer the spacing between the structures, the greater usually will be the current picked up and discharged by the unprotected one. This is particularly true where lines cross near an anode, or where two paralleling lines have branches that cross.

For a given configuration of lines, the coupling increases with earth resistivity. However, with relatively-high earth resistivity—say over 10,000 ohm-cms or 100 meter-ohms — and resultant high coupling, certain favorable conditions result, viz., (a) a relatively-small current will establish protection of the one line, and (b) the stray current is likely to leave the unprotected line over a wide area and thereby disperse its corrosive effect.

Where earth resistivity is low, the resultant coupling also is low, but the currents involved are likely to be large and to be picked up and discharged by the unprotected line within short distances and thus create a greater problem. Where lines are close together, such as under the same roadway, it appears that the most favorable condition is where the earth resistivity is high. For larger separations, the best condition is where the earth resistivity is low and the unprotected structure is far enough removed so that the coupling is small.

Stray CP Currents

Pipe and cable systems suffer damage by electrolysis in some areas caused by strong stray currents leaking from d-c, operated electric traction systems having a grounded return. Unless properly mitigated, this occurs where the current leaves the structures; however, those portions of the structure receiving the current from the soil are afforded varying degrees of cathodic protection. Where such grounded-return systems have been removed by transition to double-trolley and motor bus operation, the situation has changed in several respects.

Here the pipe and cable systems were relieved of the electrolysis, but they then suffered much more corrosion from other causes due to removal of the wide measure of cathodic protection previously provided by properly mitigated stray rail currents. As a result, many pipe and cable operators in those areas have had to install their own cathodic protection, and consequently are having to cooperate with others in new interference problems of their own making.

Street railway electrolysis has been the object of cooperative study and mitigative effort since it was first recognized in about 1910. An inter-industry committee issued a classical report[10] on the subject in 1921. Although cathodic protection as a safeguard against soil corrosion is reported to have been used as early as 1922, its effectiveness was not generally recognized until 1933.[11] The procedures today used to measure and stop cathodic system interferences are much the same as those developed years ago to combat street railway electrolysis. In metropolitan areas where subways, elevateds, and some surface railway lines remain, the mitigation of stray-current electrolysis is still a major problem.

As before stated, when newly installing or replacing buried plant, consideration should be given to the use of coatings in areas where cathodic protection systems are likely to be in operation on adjacent structures. The more difficult problems generally arise in cases where existing plant is extensive and bare, and where cathodic protection is desired. Here the engineer has no opportunity to use coatings or to select routes that will avoid stray currents.

If several separately-owned structures are experiencing corrosion in the same area, every consideration should be given to the use of joint cathodic protection, as described in Bulletin 4. Where this is not practicable, the first duty of the operator installing cathodic protection should be to notify the owners of adjacent plant of his intention, as described in Bulletin 2, and to enlist their cooperation in determining how best to avoid effects of stray currents.

For such cooperative effort, it seems impracticable to lay down general rules of procedure. From time to time cathodic protection will be used by many diverse owners of underground plant, and the job of investigating stray cathodic protection current effects will fall first on one owner and then on another, thus it seems equitable for each owner to handle the testing work on his own plant. It also seems clear that each owner should be the judge of the protective requirements of his plant. This latter prerogative, while basic, should be exercised with sound engineering judgment and an avoidance of purely arbitrary decisions.

In general, the cathodic protection system should be designed with regard to limiting its "influence," as described above. In many cases, distributing the current along the protected structure and using the minimum current consistent with good performance will reduce the stray current to a negligible amount. Where this is not feasible, consideration should be given to the placing of resistance bonds between the protected and disturbed structures. The locations for these bonds will depend on circumstances.

Where the anode or ground-bed is close to the disturbed structure, stray current will generally be picked up in the adjacent sections, and discharged back to the protected line at more remote points. In this case, the most suitable location for interstructure bonds would seem to be at these discharge points. This may not be practicable, however. It may be better to

[10]See bibliography item No. 2.
[11]See bibliography articles Nos. 4 and 5.

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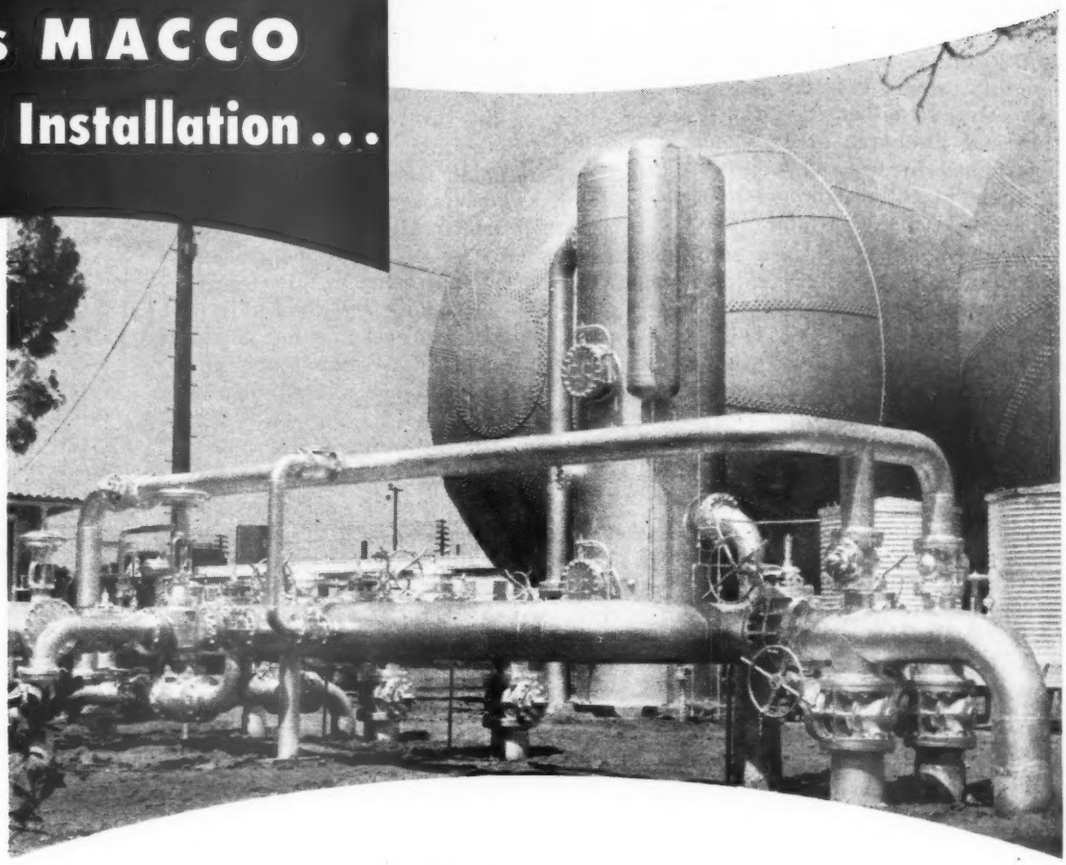

To Macco's field engineers and crewmen, pipeline jobs are not necessarily simply stringing and trenching of pipe as ordered. The piping in the natural gas meter and regulator station shown above is a typical example. With the exception of the storage tanks in the background the entire above-ground system is Macco-engineered and installed. For large or small, simple or complex pipeline jobs on the West Coast – consult MACCO.

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select a more desirable location for the ground-bed or, if such is not possible, to restrict the current pick-up by properly installed insulated joints. If the ground-bed is remote from the disturbed line, the stray currents may be collected at remote points and returned toward the power supply point where they are discharged into the soil. In this case, the best location for bonding usually is at the power supply point. In either case, the collection and discharge areas should be determined by test, since prediction of their location is impractical because of the many variables involved.

Where bonding offers a solution, the question of the total bond current required to provide satisfactory conditions must be answered. The operator installing the system will desire to keep this current at a minimum because of additional power cost. One gage of the proper bond current is to drain from the disturbed structure just enough current to reduce to zero the stray protective current discharged to earth. This is usually done by making most of the disturbed structure more cathodic than it was before the problem arose, so that it acutally receives a slight degree of protection.

When the disturbed structure has a much higher resistance to ground than the protected structure, the bond currents are relatively small; thus low-resistance bonds can be placed without substantially increasing the total current requirements of the protected structure. Where this is not true, bonds of specific resistances must be used. These resistances can be estimated from test data, but their final values are best determined experimentally by adjusting the resistances of temporary bonds until the desired condition is obtained. To reflect properly only the changes produced by the stray protective current, the tests should be made with the cathodic protection system "off" and "on." Then only the changes produced by its operation should be considered. With proper bond installation and adjustment, the adverse effects of cathodic stray current should be eliminated.

Bibliography

The Correlating Committee on Cathodic Protection gave thought to including in this bulletin some typical examples of cathodic system design and cathodic interference mitigation; however, in view of the almost infinite variety of structure configurations and conditions to be dealt with in practice, plus the need to keep this bulletin of reasonable length, the text has been confined to the presentation of general principles.

Published literature contains many articles on the various phases of cathodic protection; in fact, a bibliography[12] prepared by Prof. F. A. Rohrman of the University of Colorado lists 436 such articles published prior to 1950. Many of these have been written by recognized leaders in the field, including individual members of this Correlating Committee. The official magazine *Corrosion* of the National Association of Corrosion Engineers each month currently extracts nearly all recent articles on all phases of corrosion control. A number of representative articles are listed in Appendix B as a guide to the engineer who seeks further knowledge of cathodic system design and cathodic interference mitigation.

Appendix A

Technical practices committees of National Association of Corrosion Engineers dealing with problems relating to cathodic protection:

TP-2 Galvanic Anodes for Cathodic Protection.[13]

TP-3 Anodes for Use with Impressed Currents.

TP-4 Minimum Current Requirements for Cathodic Protection.

TP-6 Protective Coatings.

TP-8 Effects of Electrical Grounding on Corrosion.

TP-14 Instruments for Corrosion Measurements.

TP-16 Electrolysis and Corrosion of Cable Sheaths.

TP-17 Standardization of Procedures for Measuring Pipe Coating Conductance.

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[12]See July, 1950, *Oil World*, or send $1.00 to Prof. Rohrman at Boulder, Colorado, for a reprint.

[13]See item No. 54 of bibliography for first interim report of this committee.

Appendix B

Selected bibliography on cathodic protection. (V) Indicates published as a separate volume.

1. "On the Corrosion of Copper Sheeting by Sea Water and on Methods of Preventing This Effect," Sir Humphrey Davy, Phil. *Trans. Royal Soc., London, 114*, 151, 1824.
(V) 2. "Report of the American Committee on Electrolysis," published by *A.I.E.E.*, NYC, 1921.
(V) 3. "Electrolysis Testing," McCollum, Burton and Logan, *Tech. Paper No. 355, Nat'l Bur. of Stds.*, 1927.
4. "Development and Application of Practical Method of Electrical Protection for Pipe Lines Against Soil Corrosion," Starr Thayer, *API Proceedings, 14*, 23, 1933.
5. "Cathodic Protection of Underground Pipe Lines from Soil Corrosion," R. J. Kuhn, *API Proceedings*, Sec. IV, 153, 1933.
6. "Cathodic Protection of Pipe Lines in City and Country," R. J. Kuhn, *Oil & Gas Journal*, 36 (No. 18) 201, 1937.
7. "Electrical Protection of City Networks," W. R. Schneider, 4th Underground Corrosion Conference, Nat'l. Bur. of Stds., 1937.
(V) 8. "Soil and Pipe Line Protection," S. Ewing, published by Am. Gas. Ass'n., NYC, 1938.
9. "A Theory of Cathodic Protection," R. B. Mears and R. H. Brown, *Trans. Electrochem. Soc., 74*, 9, 1938.
10. "The Copper-Sulphate Half-Cell for Measuring Potentials in the Earth," Scott Ewing, AGA Technical Section, April, 1939.
11. "A Comparison of Methods for Estimating the Corrosivity of Soils," K. H. Logan and E. A. Koenig, *API Proceedings, 20*, 25, 1939.
12. "Distributed Anode Method Cuts Cost of Cathodic Protection," O. C. Roddey and L. R. Sheppard, *Oil & Gas Journal*, 38 No. 19, 84, 1939.
13. "Cooperative Problems Involved in Cathodic Protection," L. F. Scherer, *Oil & Gas Journal*, 38 No. 27, 179, 1939.
14. "Determining Minimum Current Requirements to Provide Adequate Cathodic Protection," D. Harrell and M. Clerc, *The Petroleum Engineer*, 11 No. 1, 38, 1939; 11 No. 4, 64, 1940; 11 No. 5, 51, 1940.
15. "Calculating Current and Potentials Distribution in Cathodic Protection Systems," W. F. Rogers, *The Petroleum Engineer*, 12 No. 3, 66, 1940.
16. "Intercompany Procedure Report," A. E. Koenig et al, *Pet. Ind. Elec. News*, 12 No. 2, 51, 1942.
17. "Cathodic Protection on Distribution Systems," R. M. Wainwright, *Pet. Ind. Elec. News*, 12 No. 1, 33, 1942.
18. "Null Methods Applied to Corrosion Measurements," J. M. Pearson, *Trans. Electrochem. Soc.*, 81, 485, 1942.
19. "Improper Signal Operations Due to Cathodic Protection, *AAR Signal Section Proc.*, Vol. XL, p. 153A, 281A, 1942.
20. "Locating Pipe Line Corrosion by Soil Potential Measurements," O. C. Mudd, *Pet. Ind. Elec. News*, 13 No. 3, 9, 1943.
21. "Cathodic Protection Interference," A. V. Smith, *Am. Gas. Ass'n. Monthly*, 25 No. 10, 421, 1943. *Gas Age*, 92 No. 5, 21, 1943.
22. "Measurements of Cathodic Polarization and of Problems of Interference on Underground Structures," J. M. Pearson, Corrosion Conference, Nat'l. Bur. of Stds., 1943.
23. "Concepts and Methods of Cathodic Protection," J. M. Pearson, *The Petroleum Engineer*, 15 No. 6, 7, 8, 216, 199, 219, 1944.
(V) 24. "Underground Corrosion," K. H. Logan, Circular No. 450 published by Nat'l. Bur. of Stds., 1945.
25. "Electrolysis Surveys on Underground Cables," L. J. Gorman, *Corrosion*, 1, 163, 1945.
26. "Cathodic Corrosion of Cable Sheaths," H. Halperin, *Trans. Electrochem. Soc.*, 87, 89, 1945.
27. "Light Metals for the Cathodic Protection of Steel Structures," R. B. Mears and R. H. Brown, *Corrosion*, 1, 113, 1945.
(V) 28. "Control of Pipe Line Corrosion," O. C. Mudd, published by Nat'l. Ass'n. Corr. Engrs., Houston, 1946, *Corrosion*, 1, 192, 1945, 2, 25, 1946.
29. "Corrosion of Steel and its Mitigation," W. R. Schneider, *Journal AWWA*, 37, 245, 1945.
30. "Cathodic Protection Against Steel Corrosion in Water and Sewage Works Structure," L. P. Sudrabin, *Water and Sewage*, 83 No. 5, 27, 57, No. 6, 46, 1945.
31. "The Use of Zinc for Cathodic Protection," W. H. Wahlquist, *Corrosion*, 1, 119, 1945.
32. "Cathodic Protection in the Refinery," D. Holsteyn, *The Petroleum Engineer*, 17 No. 8, 154, 1946.
33. "Galvanic Couples and Cathodic Protection," M. C. Miller, *The Petroleum Engineer*, 17 No. 8, 55, 1946.
34. "Attenuation of Forced Drainage Effects of Long Uniform Structures," Robert Pope, *Corrosion*, 2, 307, 1946.
35. "Magnesium Anodes for the Cathodic Protection of Underground Structures," H. A. Robinson, *Corrosion*, 2, 4, 1946.
36. "Economics and Effectiveness of Cathodic Protection on Large Diameter Pipe Lines," N. K. Senatoroff, *Gas*, 22 No. 7, 14, 1946; *Gas Age*, 98, 18, 1946.
37. "Our Billion Dollar Side Show—for Managers Only," H. H. Anderson, *Corrosion*, 3, 2, 1947.
38. "Cathodic Protection of 138-KV Lead-Sheathed Power Cable . . .," I. C. Dietze, *Corrosion*, 3, 432, 1947.

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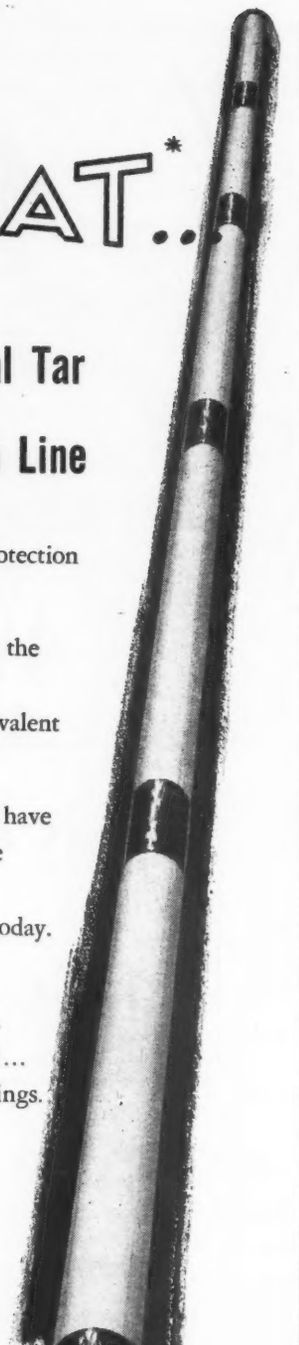

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39. "Location and Selection of Anode Systems for Cathodic Protection Units," D. B. Good, *Corrosion*, 3, 359, 1947.
40. "Galvanic Aluminum Anodes for Cathodic Protection," R. B. Hoxeng, E. D. Verick and R. H. Brown, *Corrosion*, 3, 263, 1947.
41. "The Electrical Engineer's Responsibility for Recognizing Corrosion as a Factor in the Design of Electrical Structures," M. C. Miller, *Corrosion*, 3, 347, 1947.
42. "Electrical Instruments and Measurements in Cathodic Protection," J. M. Pearson, *Corrosion*, 3, 549, 1947.
43. "Cathodic Protection Rectifiers," W. L. Roush and E. I. Wood, *Corrosion*, 3, 169, 147.
44. "Attentuation of Drainage Effects on a Long Uniform Structure with Distributed Drainage," J. M. Standring, *Corrosion*, 3, 301, 1947.
45. "Economics of Pipe Line Protection," W. R. Schneider, *Journal AWWA*, 39, 143, 1947.
46. "Principles of Cathodic Protection Design," L. P. Sudrabin and F. P. MacDonald, *Journal AWWA*, 40, 489, 1948.
(V)47. "The Corrosion Hand Book," H. H. Uhlig, published by John Wiley & Sons, Inc., NYC, 1948.
47a. "Fundamentals of Cathodic Protection," J. M. Pearson, p. 923 in 47 (V).
47b. "Application of Cathodic Protection," Robert Pope, p. 935 in 47 (V).
48. "Cathodic Protection Symposium," published by Nat'l. Ass'n. Corr. Engrs., Houston, 1948.
48a. "Coordination of Cathodic Protection Installations to Avoid Interference with Adjacent Structures," L. B. Nelson, p. 66 in 48 (V).
48b. "Relative Merits of Various Cathodic Protection Current Sources," G. R. Olson and C. W. Evans, p. 93 in 48 (V).
48c. "Corrosion and Protection of Underground Power Cables," L. J. Gorman, p. 172 in 48 (V).
49. "Fifteen Years Experience in Application of External Corrosion Mitigation Methods," N. K. Senatoroff, *Corrosion*, 4, 479, 1948.
50. "Cathodic Protection of Steel Piling in Sea Water," H. A. Humble, *Corrosion*, 5, 202, 1949.
51. "Experience and Economic Benefits from Cathodic Protection on Gas Distribution Systems," A. W. Peabody and C. L. Woody, *Corrosion*, 5, 369, 1949.
52. "Cathodic Protection of Fourteen Offshore Drilling Platforms," E. P. Doremus and G. L. Doremus, *Corrosion*, 6, 216, 1950.
53. "Interference from Forced Drainage," Robert Pope, *Corrosion*, 6, 201, 1950.
54. "First Interim Report on Galvanic Anode Tests of T.P.C. No. 2," Pub. No. 50-2, Nat'l. Ass'n. Corr. Engs., April, 1950.
55. 'Fundamentals of Galvanic Corrosion," A. B. Lauderbaugh, AGA Opr. Sec., April, 1950.
56. "First Interim Report on Ground Anode Tests of T.P.C. No. 3—Anodes for Impressed Currents," Pub. No. 51-1, Nat'l. Ass'n. Corr. Engrs., March, 1950.

* * *

Natural Gas Company to Sell Certain Properties

The Federal Power Commission has authorized The Manufacturers Light and Heat Company to acquire natural gas properties, subject to FPC jurisdiction, in West Virginia and Pennsylvania from Natural Gas Company of West Virginia. Both companies are subsidiaries of The Columbia Gas System, Inc., and have offices in Pittsburgh, Pennsylvania.

The commission's order also authorizes Natural to abandon the facilities to be acquired by Manufacturers.

The properties that will be sold include natural gas wells in West Virginia and Pennsylvania, a system of gathering lines serving these wells, two small compressor stations and three 8-in. and one 10-in. natural gas transmission lines. Purchase price of the facilities is $3,723,094.71.

Cutting "V" threads in piston rod.

Running knurling tool over "V" threads.

Maintaining Compressor Equipment

United Gas Pipe Line Company has found metalizing a valuable process in prolonging life of machine parts

FRANK H. LOVE*

METALIZING as a means of repairing and thus prolonging the life of compressor station machine parts has been found a valuable maintenance operation by the United Gas Pipe Line Company. At its Latex station machine shop in the Shreveport, Louisiana, district, metalizing equipment has been in use for several months, repairing equipment from compressor stations throughout the area. It provides a process for building up worn parts to restore them to standard size, and is a means of hard-surfacing moving parts subject to hard usage.

The metalizing machine head resembles a paint spray gun in appearance. The metal is fed into it in the form of wire, which is melted by intense heat provided by acetylene and oxygen, and the molten metal sprayed onto the part to be repaired, compressed air supplying the necessary force. Before this is done, however, the part has to be prepared to receive the metal.

One of the principal repair jobs done thus far at Latex has been the reclaiming of compressor piston rods, and this operation will be used as an example of how the metalizing equipment is used. The first step is to remove enough metal with a lathe so that the part to be sprayed is ⅛-in. under standard size. The cut is extended ½-in. beyond the worn surface at each end and the ends of the cut are undercut at a 20-deg angle. On this surface, sixteen 60-deg "V" threads per inch are cut, a rough finish being left on the threads. The threads are then rolled with a knurling tool to flatten them to some extent, forming a hook effect. This helps the sprayed metal to adhere to the surface of the piston rod.

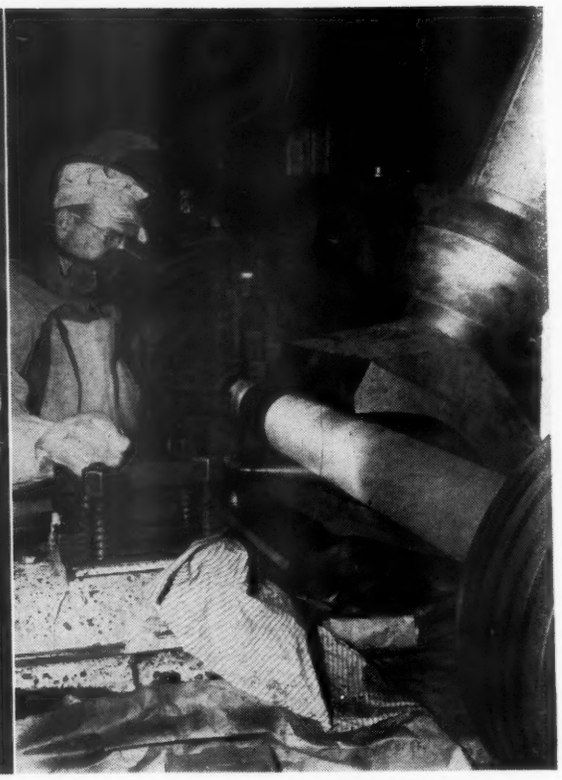
Before the molten metal is sprayed it is necessary to take certain precautions. A movable hood and flue are placed over the spot where the metal will strike the piston rod. Being equipped with a 1-hp suction fan, fumes and small particles of sprayed metal are picked up and discharged through the top of the building. Additionally, all exposed bearings on the machine are covered for protection against the metal, and the operator wears protective mask, goggles, apron, sleeve protectors, and welder-type gloves.

These precautions having been made, the metalizing gun is mounted

*Oil and Gas Pipelining Editor.

EXCLUSIVE

Spraying metal on the piston rod.



Machine parts must be covered for protection against small particles of molten metal.

in the lathe tool post. The $\frac{3}{16}$-in. metal wire is inserted in the gun, and the hoses for oxygen, acetylene, and compressed air are connected. Compressed air is provided by a two-stage compressor and at a pressure of 65 psi operates an air turbine that feeds wire from a reel through the gun at a constant rate of speed. The oxygen and acetylene are the fuel that melt the spray wire, and molten metal is blown on the piston rod as it rotates. Metal is applied to 0.035 in. oversize. The piston rod is then turned down in the lathe until it is only 0.003 in. oversize for ground finish. The surface of the rods thus treated is approximately three times as hard as originally.

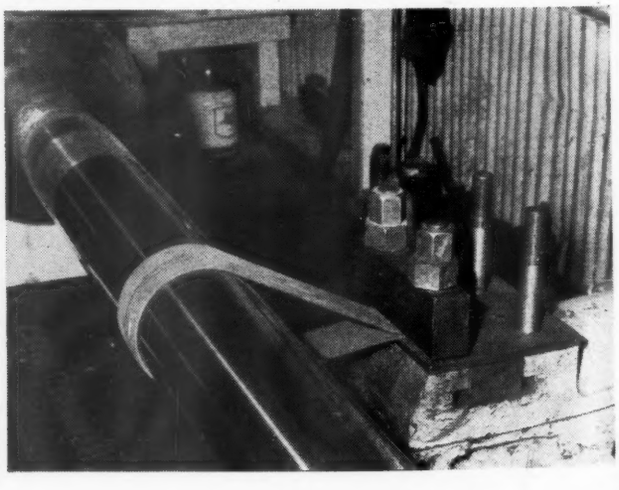
Finally, the surface is ground with an emery wheel tool post grinder to give a polished finish and reduce the rod to standard size.

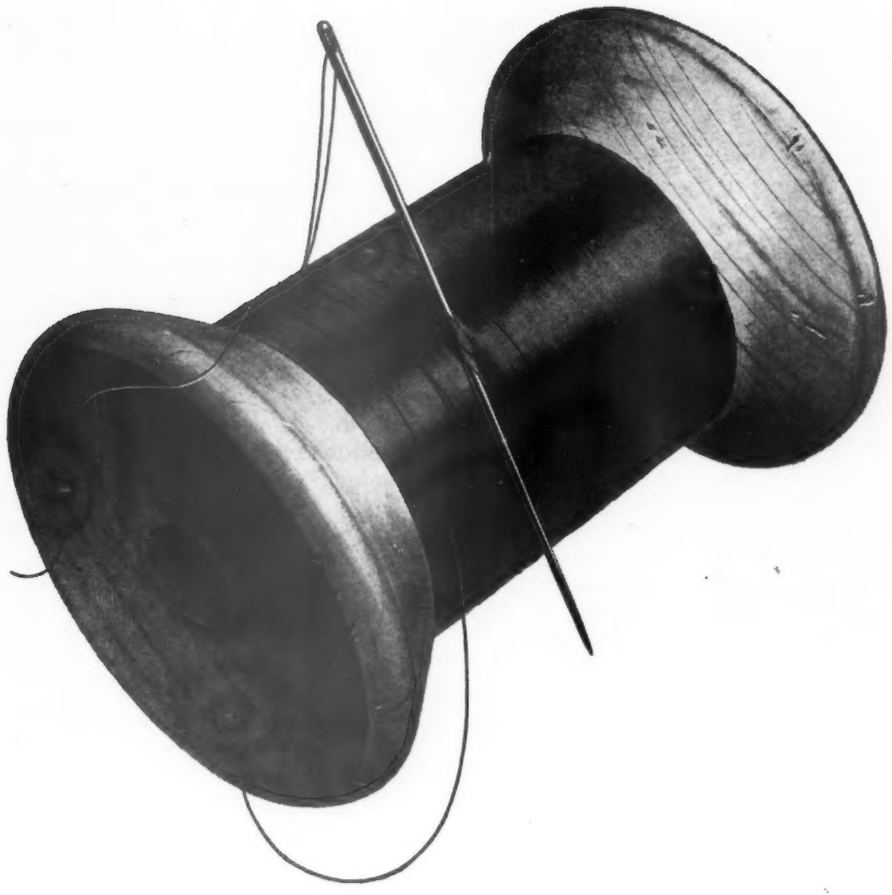
In repairing a piston rod, a copperized rod is first applied, followed by a high carbon type stainless steel. Other metals, such as aluminum, babbitt, brass, lead, nickel, tin, and zinc, can be applied to parts with the same equipment as occasion may require.

Metalizing equipment also can be used to treat against corrosion, and to prevent rust on hot piping or mufflers from which paint burns off quickly. This is done by spraying with aluminum and United has recently had a job of this kind. Mufflers for its new Koran compressor station were so treated. Because of their size, the mufflers obviously could not be handled on a lathe, as can a piston rod, so it was necessary to rig up special equipment. A turntable was devised upon which the mufflers could be placed one at a time in vertical fashion. Powered by a ½-hp motor through a 1:49 reduction gear, the table was made to turn at a speed of 11 rpm. A sliding holder for the

Piston rod being dressed with emery tool post grinder.

Polishing piston rod for final finish.





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Kaiser Steel pipe to latest API and ASTM specifications is produced in diameters from ½ inch to 30 inches, and in lengths up to 55 feet. Shipping Points are Fontana and Napa, California.

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Type	Diameter	Length	Wall Thickness	Shipping Point
Continuous Weld—Threaded and Coupled	½" to 4" nominal I.D.	Uniform 21'	Standard	Fontana, Calif.
Continuous Weld—Plain End	2⅜" to 4½" O.D.	Up to 40'	Standard	Fontana, Calif.
Electric Resistance and Fusion Weld—Plain End	8⅝" to 20" O.D.	Up to 40'	.188" to .500"	Napa, Calif.—Basalt-Kaiser
Electric Resistance Weld—Plain End	5 9/16" to 12¾" O.D.	Up to 55'	.188" to .400"	Fontana, Calif.
Electric Fusion Weld—Expanded—Plain End	22" to 30" O.D.	Up to 40'	.188" to .500"	Napa, Calif.—Basalt-Kaiser

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Spraying compressor mufflers with aluminum as protection against corrosion.

metalizing gun was made to fit over an upright piece fashioned of 1½-in. pipe into which holes had been drilled lengthwise. Pins beneath the gun held it in position for spraying while the muffler was rotated. When the table had made a complete rotation, the gun was dropped down by the simple means of removing the pin and placing it in the next lower slot, and continuing the procedure. The calculation was such that as the gun was lowered the metal was applied in a slight overlap, in order that there would be no untreated areas. Two men were required for the operation, one to regulate the gun and the other to move the pins. Prior to application of the aluminum, the mufflers were prepared by sandblasting to remove all rust or other foreign matter. After the aluminum was applied, the surface was air-sprayed with plastic lacquer.

* * *

Natural Gas Operating Revenues Show Increase

Operating revenues of natural gas companies reporting to the Federal Power Commission totaled $151,511,608 in March, 1951, an increase of 14.5 per cent over the $132,303,874 reported for same month a year ago.

Gas utility operating income for March, 1951, amounted to $27,533,630, up 4.5 per cent from the $26,351,570 reported for March, 1950. Net income for the month was $23,286,118 compared to $23,593,111 reported in March, 1950.

Gas operating revenue deductions amounted to $124,101,472, an increase of 17 per cent. Of this total, operating expenses accounted for $90,741,065, up 11.6 per cent; depreciation for $10,315,513, up 16.4 per cent and taxes for $23,044,894, up 44.7 per cent.

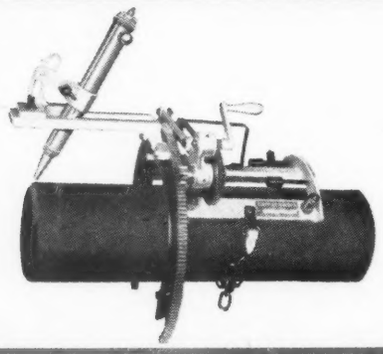
Gas sales to ultimate consumers in March, 1951, were 210,469,000,000 cu ft, an increase of 11.5 per cent over March, 1950. Sales to residential consumers increased 8.4 per cent and to commercial and industrial consumers 3.9 per cent and 13.5 per cent, respectively. Revenues from sales to ultimate consumers increased 10.9 per cent and amounted to $77,585,755. Revenues from the three classes of service—residential, commercial, and industrial—increased 8.3 per cent, 5.5 per cent, and 17.7 per cent, respectively.

For the 12 months ended March 31, 1951, gas operating revenues aggregated $1,397,366,599, an increase of 27 per cent over the previous year.

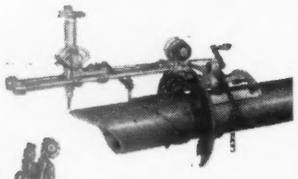
* * *

for SPEED and ECONOMY use . . .

H&M PIPE CUTTING and BEVELING MACHINE



ATTACHMENTS



Shape Cutting Attachment for cutting the various shapes of pipe intersections.

Out-of-Round Attachment is used when pipe is out of round.

speed . . . . . Split horseshoe shaped gear permits machine to slip quickly over pipe. Fast operating snap chain fasteners hold it in place. A complete cut and bevel can be made in a 12 inch pipe in about two minutes.

economy . . . You'll soon save several times the cost of the machine in labor, gas and transportation charges. H&M takes approximately one-half the labor and gas to make the cut as hand cutting and the work is all done in the field.

portability . . Bring this light (24 to 155 pounds) but durable machine to the pipe instead of moving the heavy pipe to the machine. Remember, H&M designs for SPEED and ECONOMY.

Let us arrange a demonstration to show you how H&M will save you money and time. Or write for further details . . .

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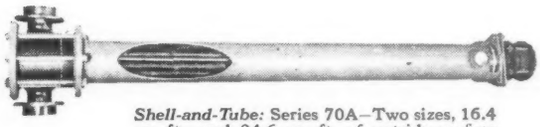
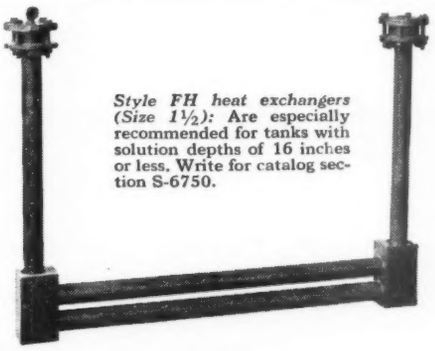
"KARBATE" BRAND IMPERVIOUS GRAPHITE HEAT EXCHANGERS *FOR ALL PURPOSES!*

The "Karbate" impervious graphite heat exchangers illustrated are used extensively as boilers, coolers, condensers, vaporizers, evaporators, heaters and absorbers in handling corrosive chemicals, either hot or cold. They *all* can be had in a complete size range. *All of them* offer the following advantages:

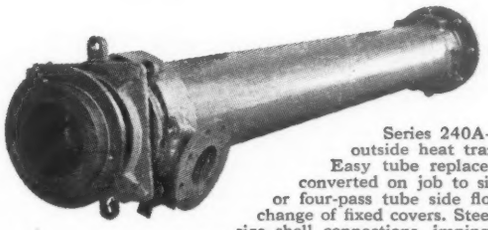
- **Highest heat conductivity rate of the practical corrosion-resistant materials.**
- **Highly resistant to corrosion by acids or alkalis, hot or cold.**
- **Freedom from corrosion scale, as compared to metals.**
- **Immune to thermal shock.**
- **No contamination of product.**
- **Strong and easy to install and maintain.**



Shell-and-Tube: Series 70A—Two sizes, 16.4 sq. ft., and 24.6 sq. ft. of outside surface area respectively. Tubes easily replaced in the field. Interchangeable single and double-pass construction.

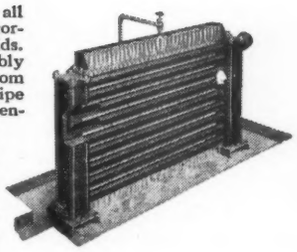


Style FH heat exchangers (Size 1½): Are especially recommended for tanks with solution depths of 16 inches or less. Write for catalog section S-6750.



Series 240A—70.6 feet of outside heat transfer surface. Easy tube replacement. Easily converted on job to single, double, or four-pass tube side flow by simple change of fixed covers. Steel, shell, oversize shell connections, impingement plates and drain and vent plugs integral with shell end castings. Stainless-steel baffles assembled with steel tie rods to form protective cage for tube bundle. Removable "Karbate" tube bundle. Write for catalog sections for S-6690, S-6715 for details of applications, maintenance, sizes and characteristics of these exchangers.

Cascade coolers: For all cooling jobs involving corrosive gases and liquids. Complete cooler assembly may be made quickly from 4 standard items in 5 pipe sizes. Capacity easily enlarged or reduced by adding or subtracting standard sections. Compact construction to save plant room. No special supporting structure needed. Write for catalog section S-6780.



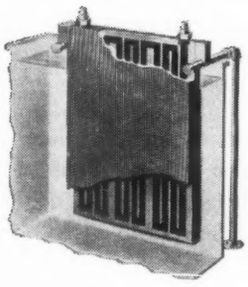
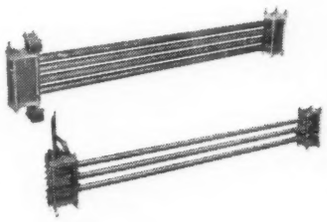


Plate heaters: Used to heat or cool corrosive liquids in tanks and vessels. Compact, completely assembled, easy to put in. Used in pickling, etching, plating and cleaning tanks. Complete size range. Models for horizontal and vertical mounting. Write for catalog section S-6620.



Concentric Tube exchangers: Available in two types. Series 10A is small, low-priced, gives true counterflow. Exceptionally good for small flow rates at narrow temperature differences . . . Series 20A manufactured with "Karbate" inner and outer piping, and is used to transfer heat between two corrosive fluids. Both have sectional construction, can be added to or subtracted from at will. Sturdy, can be moved from place to place after assembly, adapted to any method of mounting on floor, wall, or ceiling. Write for catalog section S-6670.

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A full line of "Karbate" impervious graphite pipe and fittings

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Jacking up the power house and leveling it off prior to pouring concrete piers.

Piers, one under each column, have slots to insert redwood boards to enclose cellar space.

Subsidence Phenomenon Pesters Pipeliners

Shell's Cheney station has been subjected to unusual stresses and strains—Here is a record of what has been done about it

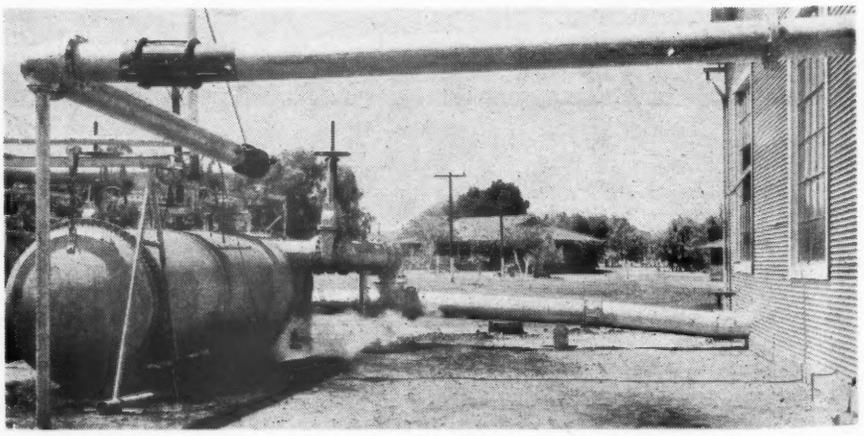
RICHARD SNEDDON*

EVER since its completion in 1915, Shell Oil Company's Cheney pump station, near the south end of the Coalinga-to-Martinez pipe line in California, has been subjected to periodic stresses and strains resulting from a distinctly unusual species of soil subsidence. It was at first thought that this land movement might be in part at least caused by an active geological fault in the immediate area, but, as no evidence could be developed in support of such a contention, the theory was abandoned.

The reason for the subsidence, however, now seems to be well established. The plant stands on an alluvial fan that dips quite steeply in an easterly direction and consists, to a considerable depth, of a fine, very loosely compacted soil. When this soil is watered by rainfall, flood, artificial irrigation, or, indeed, any other means, it settles to a most remarkable extent. In the four or five square miles on which the station centers and which is covered all over by the same fluffy kind of earth, there are many sizable pits and irregularities that have been caused by merely watering the ground. About a mile southeast of the station, for example, one fair sized irrigation sump, only three months old, has already sunk to a depth of approximately 12 ft.

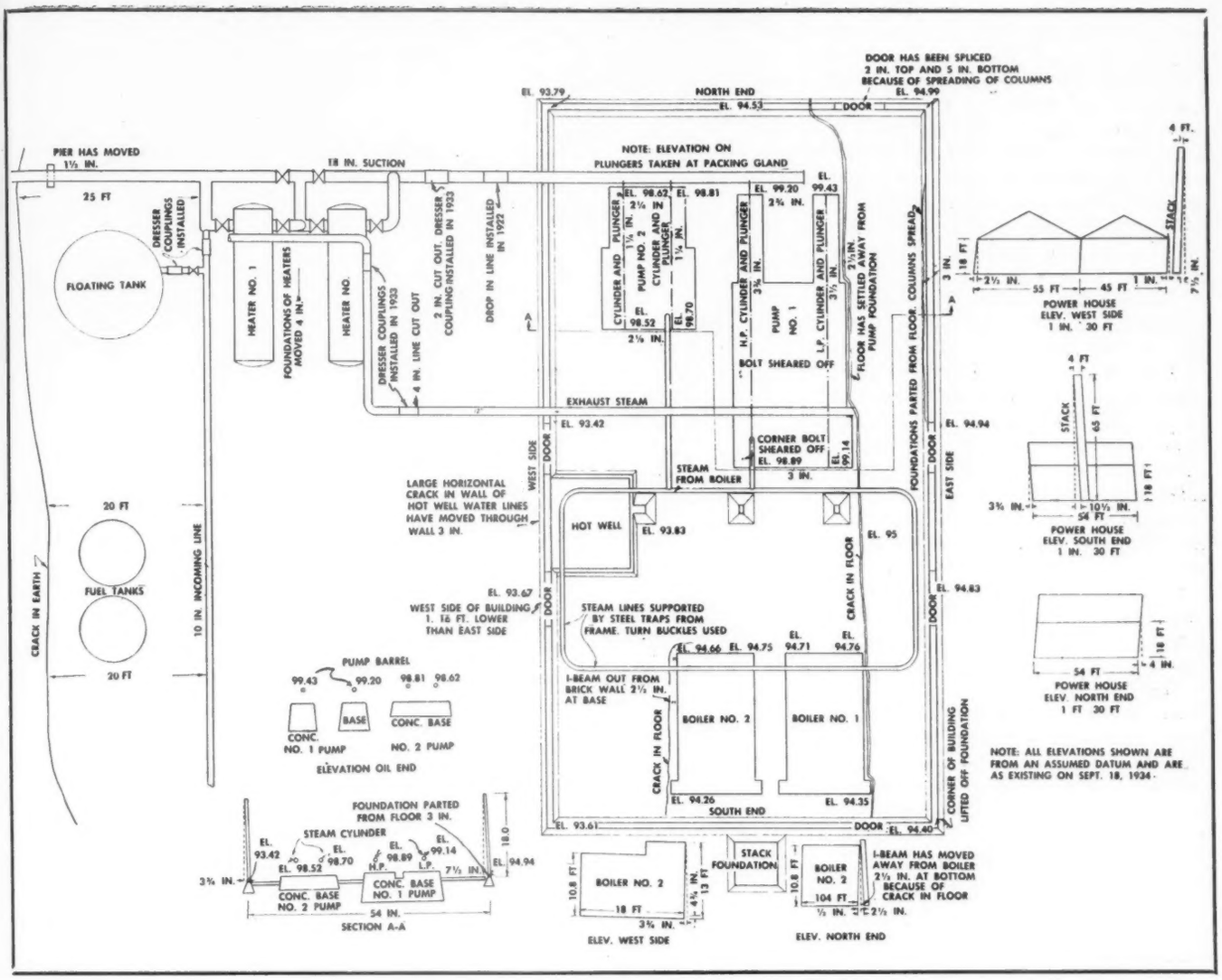
Almost immediately after the construction of the Cheney station, it was noted that the foundations were settling and cracking. Efforts were made

Showing offset in 18-in. suction line between heaters and main pumps. Originally line was level—it now has a drop of about 10 in. Heaters have not settled to any appreciable extent, indicating settling of pumps inside building. Note two couplings installed to relieve strain.



*Pacific Coast Editor.

EXCLUSIVE



Settlement of equipment and damage to the building at the Cheney station, of the Shell Oil Company

to retard the process by discontinuing the irrigation of lawns, and building tile drains to check the seepage of water toward the building. Quite early in the proceedings, however, the water well casing was broken at a depth of about 40 ft by the shifting ground. This was repaired by excavating down around the outside of the casing and welding the break. By 1922, despite these efforts, the damage was so extensive that part of the building and foundations had to be renewed. Excavations were made under the pump foundations and there were filled with concrete to widen the base, after which the pumps were levelled.

In addition, adjustment had to be made in the 18-in. suction line and the 8-in. bypass line to relieve the strain on the piping. In 1925 the water well was damaged at a lower depth than on the former occasion and an air-lift system had to be substituted for the pump. These general repairs corrected the condition for a few years but by no means provided permanent correction. A later survey of the situation by company engineers showed that considerable further settlement had taken place, although not enough to justify any immediate drastic remedial measures.

In December, 1934, M. C. Alcorn, now assistant manager of pipe lines for Shell in California, made an extensive report on a survey that had been conducted some two months earlier. This included a definition of the damage that had been done to that time and debated two alternate remedial plans. It is interesting to note that in some respects the damage incurred between 1932 and 1934 was much greater than that which had been revealed in any of the other reports on prior surveys and this despite the fact that specific attempts had been made to increase the stability of the building and foundations, and to counteract as far as possible the effect of the subsidence.

The following tabulation illustrates this point:

Date of survey	Pump No. 1 Steam end	Oil end
August 1928.....	0.06 ft low	0.11 ft low
February 1922.....	0.08 ft low	0.16 ft low
September 1934.....	0.25 ft low	0.23 ft low
	Pump No. 2	
August 1928.....	0.13 ft low	0.11 ft low
February 1922.....	0.11 ft low	0.16 ft low
September 1934.....	0.18 ft low	0.19 ft low

All these measurements were taken at the left hand side, which was the low side of the pumps.

Regardless of this unevenness, there was no apparent effect on the operation of the pumps, which continued to function smoothly. The strain on the foundation, however, was evident in the fact that two foundation bolts on the No. 1 pump, a large Dow flywheel unit, had been sheared completely off and the floor had moved away from the foundation all along the opposite side to the extent of some 2½ in.

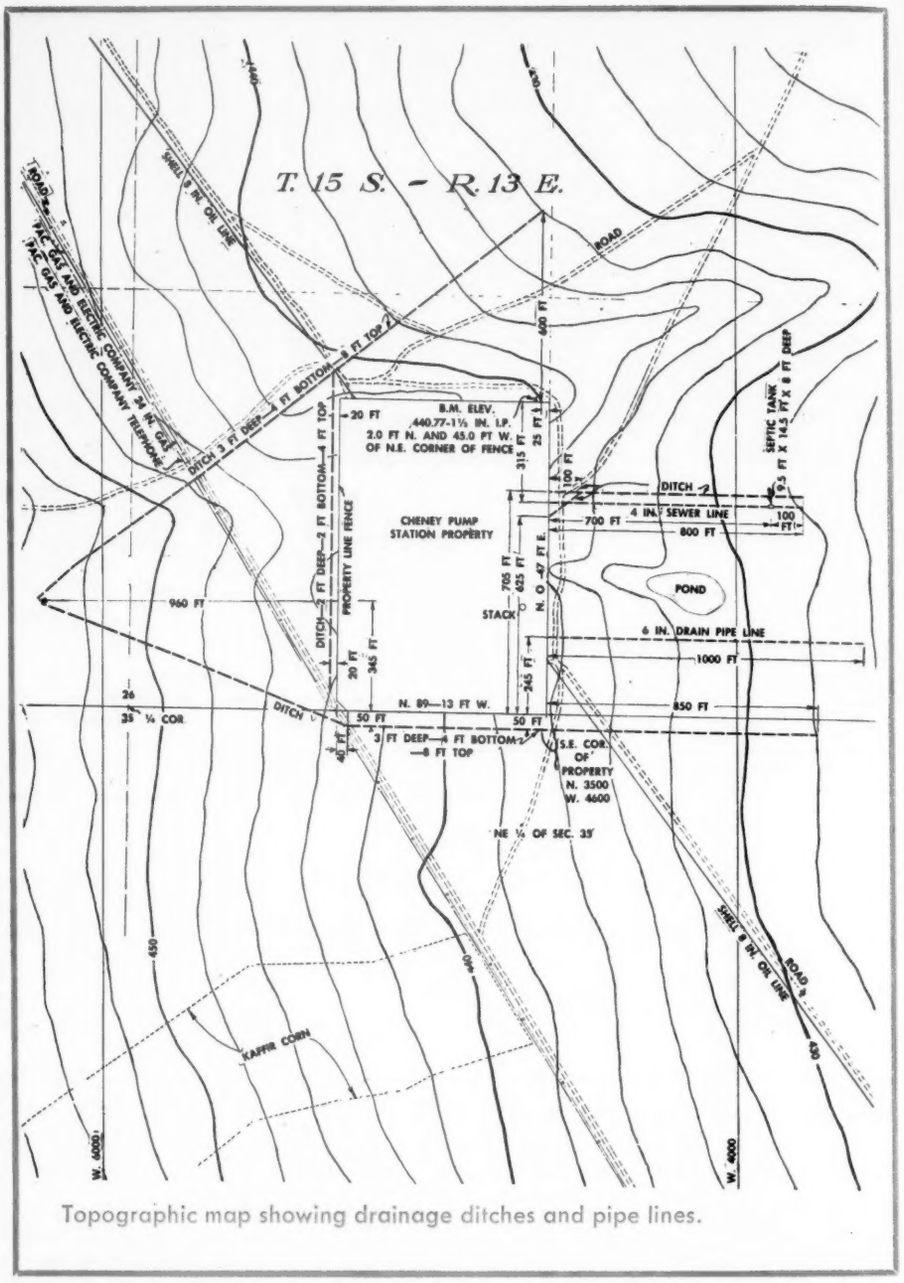
The 1924 survey showed that the fronts of the two boilers had settled very little, the No. 2 unit was off level

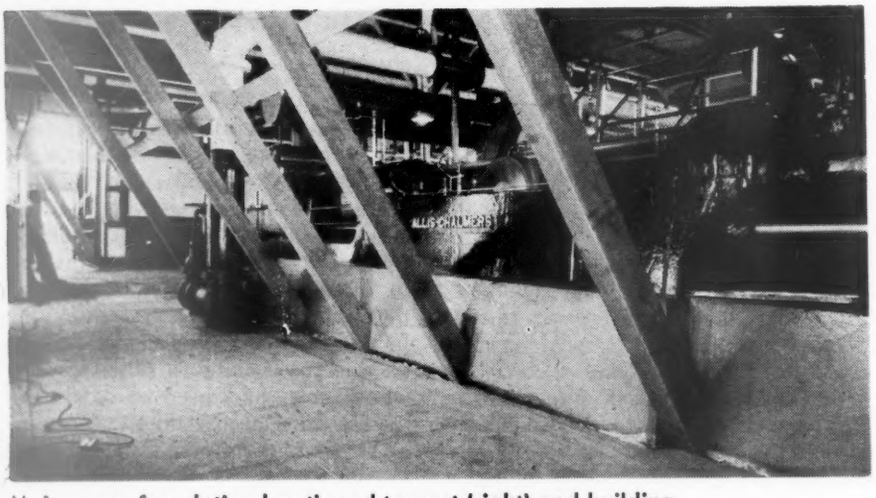
about 1.25 in., but the base of the rear end of each was found to be 5 in. lower than the front. Coincidentally, the floor had settled in this section, leaving the base of the boilers 1 ft above the floor of the hotwell pit. The boilers themselves were intact but it was noted that one of the vertical I-beams supporting the No. 2 boiler had moved away from the floor for a distance of 2.5 in.

The entire west side of the building foundations and floor had settled more than a foot lower than the east side as a result of which the structure was tilted toward the west and was out of plumb some 3.75 in. between the eaves and the ground. In addition, a part of the foundation along the east side had moved laterally in an easterly direction about 3 in. so that some of the channel irons that constituted the building columns were out of plumb a full 7 in. This condition was serious enough to threaten a collapse and bracing was immediately installed to avoid any such contingency.

The foundation and floor of the building were cracked and ruptured in many places, making the floor quite uneven. One large crack, approximately 2 in. wide, extended from the south end of the building along the east side of boiler No. 1 to the north end of the building. This was filled in as a temporary safety measure. It was also noted that the settling of the west side of the building had lifted the southeast corner off its foundation.

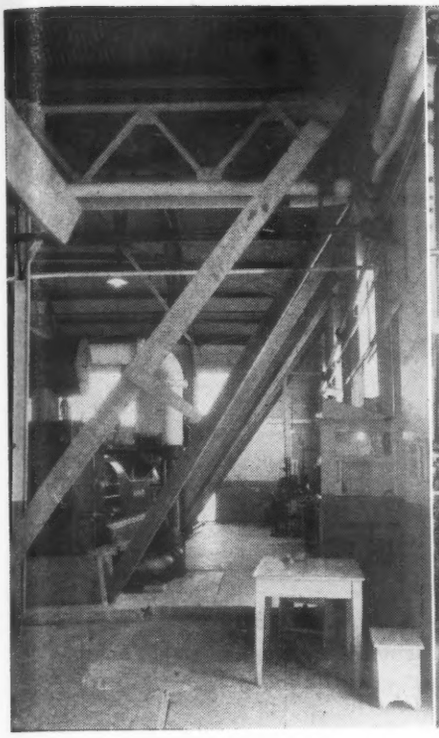
Since the station had first been put into operation, the piping had been examined meticulously at intervals and steps had been taken from time to time to relieve any undue stresses and strains that might show up. In December 1932, the pump discharges had been disconnected and rearranged for this reason. In 1923, the


T. 15 S. - R. 13 E.
ROAD
SHELL 8 IN. OIL LINE
PAC. GAS AND ELECTRIC COMPANY 24 IN. GAS
PAC. GAS AND ELECTRIC COMPANY TELEPHONE
DITCH 3 FT DEEP—4 FT BOTTOM—8 FT TOP
B.M. ELEV. 440.77-1½ IN. I.P. 2.0 FT N. AND 45.0 FT W. OF N.E. CORNER OF FENCE
CHENEY PUMP STATION PROPERTY
PROPERTY LINE FENCE
DITCH 2 FT DEEP—2 FT BOTTOM—4 FT TOP
DITCH 2
4 IN. SEWER LINE
SEPTIC TANK 9.5 FT X 14.5 FT X 8 FT DEEP
POND
STACK
6 IN. DRAIN PIPE LINE
1000 FT
850 FT
800 FT
700 FT
960 FT
N. 89—13 FT W.
35 ¼ COR.
3 FT DEEP—4 FT BOTTOM—8 FT TOP
S.E. COR. OF PROPERTY N. 3500 W. 4600
NE ¼ OF SEC. 35
KAFFIR CORN
W. 4000'
Topographic map showing drainage ditches and pipe lines.

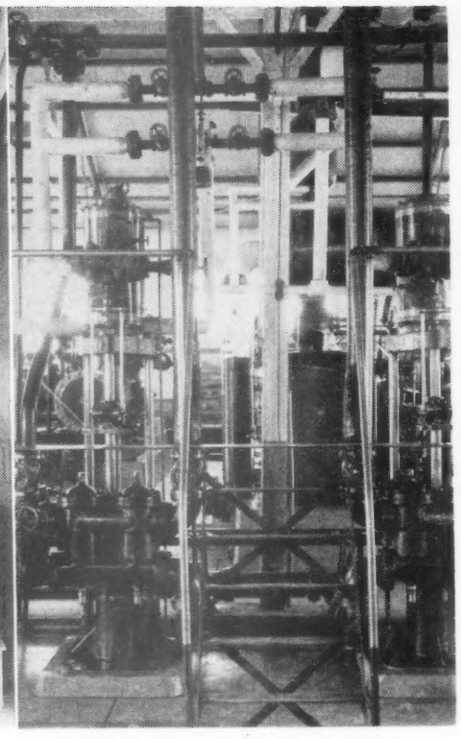

Main pump foundation has tipped to west (right) and building foundation and floor have moved east (left). View shows crack and movement at pump foundation and floor line. Timbers were installed in October, 1934, to prevent possible collapse of building.

18-in. suction line was cut, 2 in. were taken out, and Dresser couplings were installed to absorb the shocks. Other Dresser couplings were installed in the connection to the floating tank.

Because of broken flanges and strain on the 12-in. exhaust steam line to the heaters, a piece of pipe 4 in. long was cut out and two couplings were inserted. That was in 1935, and at the same time other smaller lines were similarly protected. The main steam lines from the boilers to the pumps were so constructed as to be quite flexible, but as a precautionary measure they were equipped with steel straps and turnbuckles, suspending the line from the roof so that it could be lowered or raised as required. In 1934, the large gooseneck connections to the boilers and pumps were disconnected but were found to be under no strain.



Note that steel column on left is out of plumb about 6 in., the bottom having moved westerly with foundation wall, which cracked at X. (Crack has been patched.)



Steel column in center of this plate, under heavy strain, has a distinct "bow" as well as being several inches out of plumb. Boiler feed pumps are out of line and piping under strain.

The smoke stack was out of plumb by 10.5 in. between the top and the base, and, as it was guyed to the building on the west side, tended to be pulled over as the building moved. The stack was further disclosed to be leaking slightly at the breaching and it was the conclusion of the Alcorn report that it would soon have to be replaced.

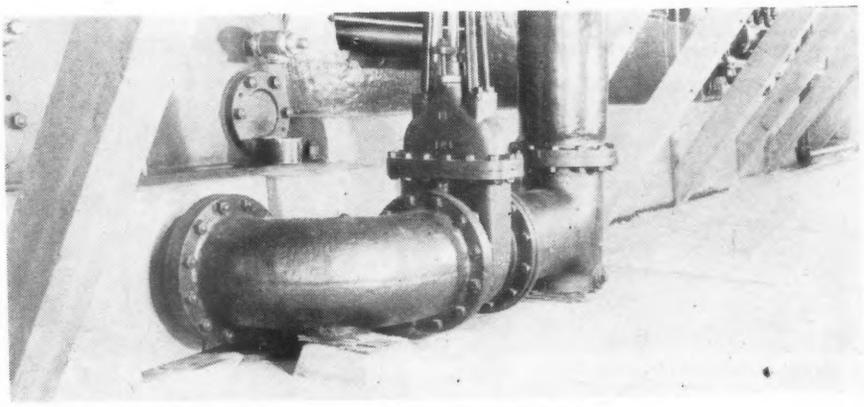
In view of all this damage, which may be seen in detail in the accompanying photographs and line drawings, the examining engineer discussed two alternate plans of correction. The first projected a program of adjustment and renewal of building foundations and floors; leveling the pumps; straightening the building, and replacing the smoke stack. It was assumed that, 12 years having elapsed since adjustments were previously made, it would be profitable to continue the process of careful maintenance and adjustment and meantime take such new protective measures as might prolong the effective operating life of the station. The second plan offered the much more expensive alternative of relocating the station some 3 to 5 miles farther north and was not endorsed because of the high cost involved and the additional fact that it would increase the pressure at the initial station and reduce the capacity of the line.

In actuality the first plan has been carried out and appears to be accomplishing all that is required of it; however, the process of rebuilding, leveling, and straightening has been accompanied by a system of drainage and remote water disposal that is undoubtedly the controlling factor in the whole situation. A series of strategically located ditches have been excavated to keep flood waters and waste waters at a safe distance from the station site. A septic tank, situated near the pump house, has been supplemented by another 150 ft away. The overflow from this latter is discharged about 700 ft farther from the building. In like manner drainage from the vicinity of the power house is conducted to a safe distance before being discharged into the earth. Even the rain water from the eaves is carried well out before being released.

The soil being loosely compacted, as already indicated, is highly absorbent, and water disposal presents no particular problem. Geologists, indeed, have intimated that the light surface soil is present to a depth of at least several hundred feet over a wide area in the neighborhood of the station. The compacting that results when this soil is wetted has seemingly been the major cause of all the trouble here discussed, however, and it is obvious that the removal of the water-absorbing process to a safe distance constitutes the most important factor in the protection of the Cheney station.

With the ditch system to take the run-off where it can do no harm, and all water discharges from the station also situated outside the effective area, there is every reason to believe that the entire plant can be maintained in apple pie order. At the moment, apart from a slightly tilted smoke stack and a pair of storage tanks that are somewhat askew, neither of them sufficiently out of plumb to cause concern, there is nothing to indicate that the station is not a normally functioning unit.

After the 1934 survey, in addition to the installation of the ditching and drainage system, the building was jacked up and the original solid wall foundation was replaced with separate piers—one under each column. These were slotted for the insertion of redwood boards to enclose the cellar space. The individual piers will



Twelve-inch exhaust fittings from No. 1 pumping engine. The floors and foundation have shifted; note shims placed under elbow and vertical sizer fitting to take weight.

permit easy adjustment should there be any further spot-subsidence and will thus simplify the keeping of equipment and machinery on level planes at the proper elevations.

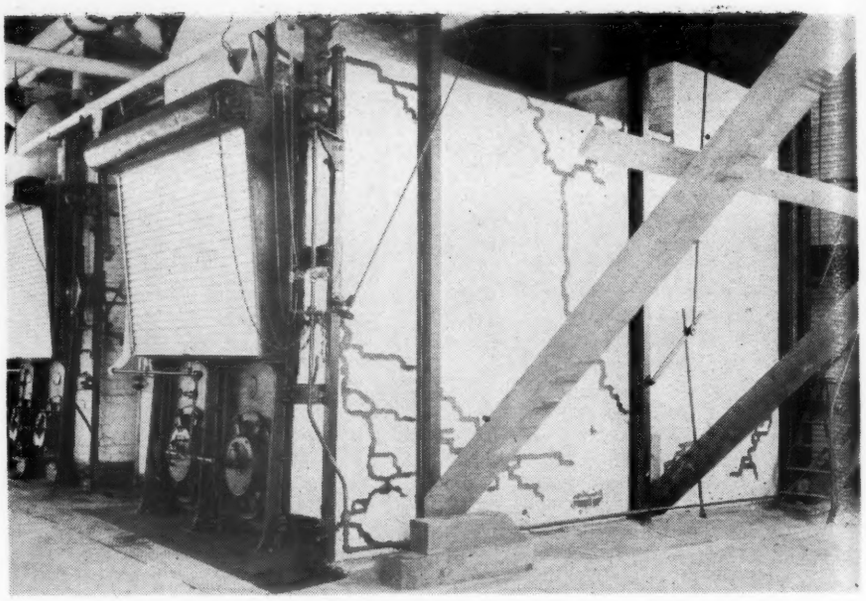
Other measures that were taken to incorporate greater stability into the plant were as follows: The concrete foundations under the main pumps were built up to the requisite level by holding the high corner and raising the low sections to this level. (This eliminated the necessity of cutting any concrete.) New foundations were built under the boilers with an air-cooled space being provided to minimize transfer of heat from the shells to the soil. Building foundations and floors were renewed and leveled and pipe connections were realigned where necessary. The smoke stack was also replaced and, indeed, everything was done that seemed to be immediately necessary to reestablish the original solidarity and relationships. The employee cottages, which had acquired a rakish tilt, with a difference of 0.4 ft between the high and the low corners, were restored to their original level.

It is worthy of note that despite the apparent instability of the station site, engineers and geologists are convinced that it is the most solid bit of terrain in the five (more or less) square mile piece of which it is the center. Ranchers in the vicinity have had a rugged time trying to control irrigation. The ditches have a provoking habit of enlarging and deepening in unusually quick time. Water well casing shears and collapses; telephone poles look as though they had been installed by someone with a tendency to dizziness. The soil is eroded by irrigation and rain water until it is irregularly and deeply gashed with arroyos that make the rest of the terrain look like a mesa of considerable height.

The whole thing is just one of these natural oddities that occasionally intrude themselves into the best laid plans of mice and men. Flying across the area or even driving by casually, one would find nothing particularly forbidding about this stretch of light, tan colored territory. That must have been especially true when the site of the Cheney station was first selected. There was then no activity in the district to give an inkling of the prankish nature of the soil and as likely as not the calculations of the engineers placed the station in the precise spot that it now occupies.

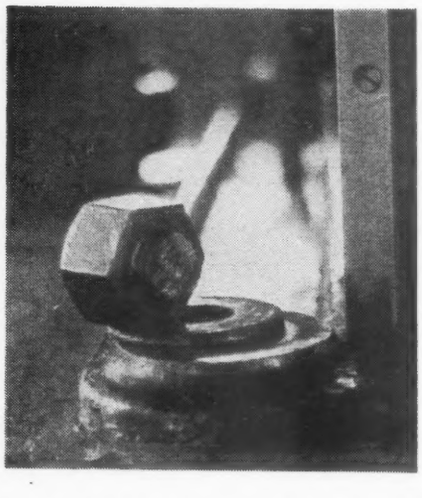
In any case, it is experience of this type that whets the ingenuity of the scientific mind. Such alterations and adjustments as have been required to cope with a distinctly rare situation have cost but a small fraction of what it would have taken to relocate the station somewhere outside the vulnerable area. Also—an important consideration—under the remedial system adopted, the station has been able to run uninterruptedly at full capacity. These are not accidental circumstances! On the contrary, they are the result of a careful weighing of all the facts and an eventual improved understanding of the involved causes and effects.

From these studies and deliberations came the plan that has been adopted—a process of periodic adjustment when and where needed, and constant protection from the destructive element, in this case, water. The system is economically sound and operationally successful, and about the only thing that might interfere with its continued success is some cataclysmic event such as a tropical cloudburst or an earthquake of major intensity, to which even the most stable structure might be vulnerable.* * *



No. 2 boiler has moved southwesterly, brick work has cracked and been patched from time to time with plastic material. The movement has been quite severe and foundation cracked in several places.

High pressure foundation bolt 1 ½ in. in diameter broken off.



REPAIR LEAKS
QUICKLY—PERMANENTLY

SKINNER-SEAL PIPE JOINT CLAMPS stop leaks at joints. Put on under pressure—without interruption of service. Quick, simple, lasting repair. Sizes 1/2" to 24" incl. in stock.

SKINNER-SEAL COLLAR LEAK CLAMP—designed to stop every type of collar leak in oil and gas lines. Sizes: 2" to 13" inclusive.

M. B. SKINNER COMPANY
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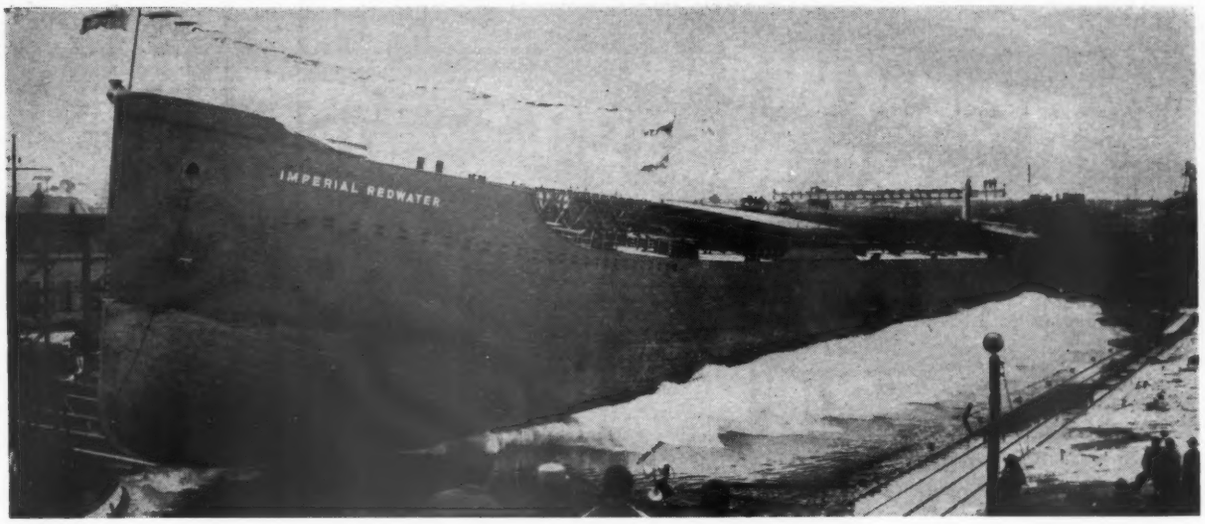


Tankers for Interprovincial Service

Two largest fresh water tankers in world have been launched—Will be used to move crude oil across Lake Superior to Sarnia.

HARRY CHAPIN PLUMMER

General view of construction on *Imperial Redwater*, showing bulkheads in position at Port Arthur Shipbuilding Company's yards.

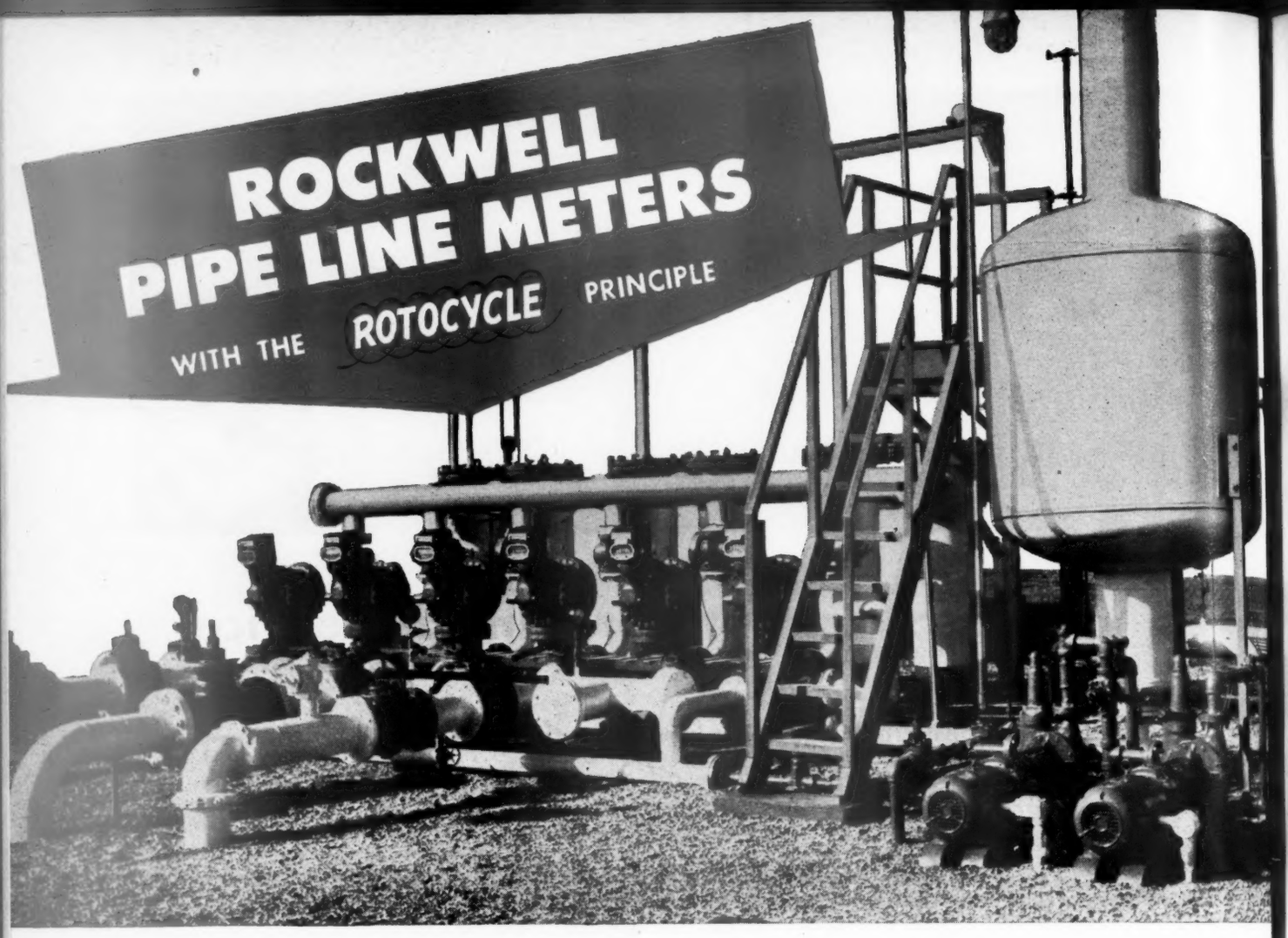
NEW records were established for Canadian shipbuilding and still others presaged for Canadian inland waterway navigation, when two giant oil tankers for Great Lakes service, both sister ships and the largest of their type ever to be built in the Dominion, were successfully launched eight months following the laying of their respective keels. The *S.S. Imperial Redwater* received its baptism of champagne at Port Arthur, Ontario, on Lake Superior, sponsored by Mrs. C. D. Howe, wife of Canada's minister of trade and commerce.

The 620-ft craft, virtually a duplicate of the *S.S. Imperial Leduc*, launched at Collingwood, Ontario, at the foot of Georgian Bay, Lake Huron, a fortnight earlier, is to have 68-ft beam, 35-ft depth, and 15,800 deadweight tonnage. Her cargo capacity will be 115,000 bbl on a 24-ft draft. The construction cost of each is about $4,000,000. Both vessels are to be the largest fresh water tankers in the world and the largest ever built in shipyards in that country. The launching of the *Imperial Leduc* was sponsored by Mrs. N. E. Tanner, wife of the minister of mines and minerals of the Province of Alberta.

The builders of the *Imperial Leduc* were the Collingwood Shipyards Ltd., of the *Imperial Redwater* the Port Arthur Shipbuilding Company, Ltd. Both craft, following completion and trial runs will become integral units of the Interprovincial Pipe Line Company system, extending overland 1127 miles from Edmonton, Alberta, to Superior, at the head of the lake of that name, and by water thence to Sarnia, Ontario, at the foot of Lake Huron, another 700 miles. Each ship will make the round trip in five days.

The owners are Pipe Line Tankers, Ltd., from whom Imperial Oil Limited, of Toronto, has chartered both craft for a 15-year period. It is estimated that the two carriers will transport 5,000,000 bbl of oil each navigation season.

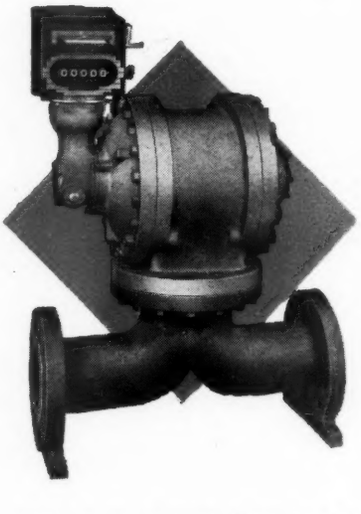
* * *



PAY OFF *where you take off!*

When you guard your take-offs with Rockwell Rotocycle meters you protect your pay-off points in two ways. First you gain the mechanical advantages of a proved meter design that has rolled up impressive durability records on the nation's leading pipe lines. Second you are assured of precision accuracy that accounts for every drop of throughput and every penny of return.

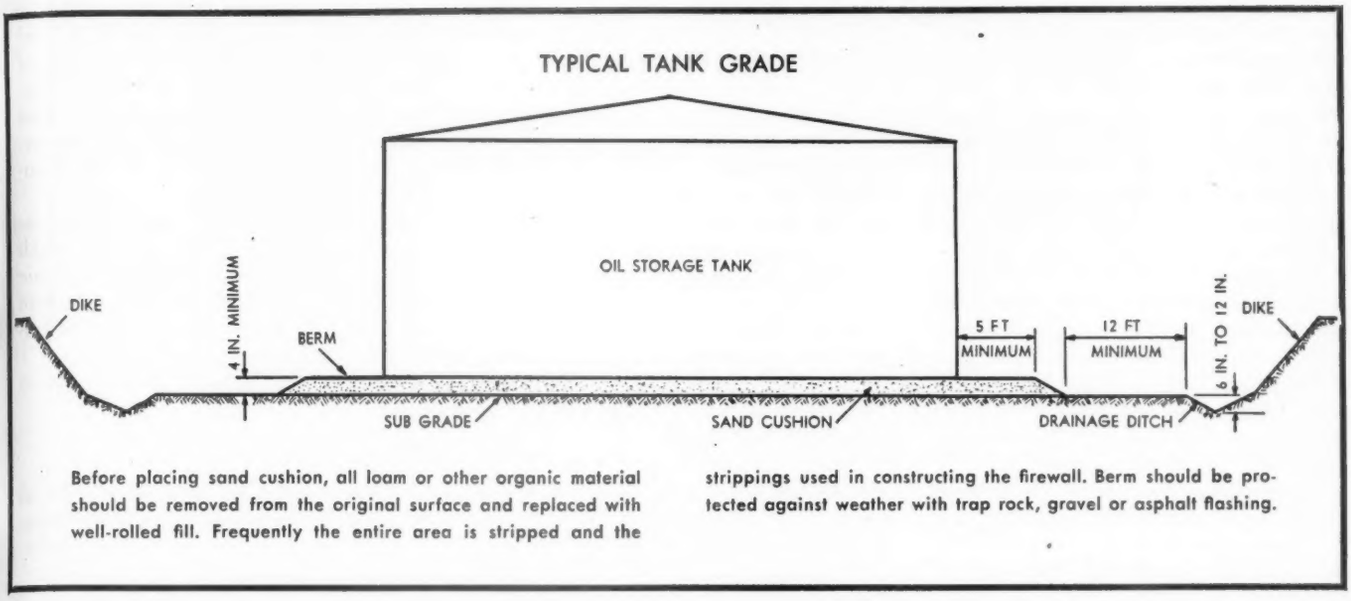
Rockwell Rotocycle meters are made in five sizes for either high or low pressure service and may be optionally fitted with temperature compensators, straight reading or printing registers. Write for bulletins and case histories of actual operator's experience.



Model 6 PL Rockwell Rotocycle with printing register. Capacity 1150 barrels per hour.

Rockwell MANUFACTURING COMPANY
PITTSBURGH 8, PA.

Atlanta Boston Chicago Columbus Houston Kansas City
Los Angeles New York Pittsburgh San Francisco Seattle Tulsa



Before placing sand cushion, all loam or other organic material should be removed from the original surface and replaced with well-rolled fill. Frequently the entire area is stripped and the strippings used in constructing the firewall. Berm should be protected against weather with trap rock, gravel or asphalt flashing.

OIL STORAGE TANK FOUNDATIONS

To obtain the proper tank service good foundations must be provided

IRVING E. BOBERG*

Too often the importance of foundations is underestimated. Since the flat bottomed oil tank is one of the simplest types of structure and has sufficient flexibility to accommodate appreciable changes in shape, the foundation on which it rests is frequently given little consideration.

With the advent of larger and higher tanks, the effects of poor foundations were multiplied. The larger tank not only imposes a heavier load and hence causes greater settlements, but the distortion caused by any given settlement is, in some measure, proportional to the size of the tank.

In addition, the floating roof user has become increasingly conscious of the importance of a shoe-to-shell fit that is as nearly perfect as possible. It must be obvious that perfection can best be attained if the tank shell is built circular and remains circular within reasonable limits.

If the grade is not level in the beginning, or if it later settles unevenly, the tank will inevitably have a distorted shell. Often the tank builder is blamed for a poor shell that should properly be charged to a poor foundation. In order to obtain good tanks, good foundations must be provided.

Proper grade preparation can also have an important bearing on bottom corrosion. Tanks erected on poorly drained grades, directly contacting corrosive soils or on heterogeneous mixtures of different types of soils, are all subject to electrolytic attack on the bottom side.

There is no rule of thumb that can be applied to all situations. Each case must be evaluated on the basis of conditions as they exist. Local conditions vary so widely that it would be impossible to anticipate them all. An attempt has been made in the material that follows to deal with the more common aspects of tank foundation design.

In selecting the proper type of foundation, the bearing power of the soil is the primary factor. Where no previous experience in the same area is available, soil borings to determine existing conditions are usually cheap insurance against future trouble. We have seen a number of instances where tank sites were judged solely from surface conditions only to have the empty tanks settle so seriously during construction that the water test could not be performed until the foundation was rectified. With the tanks already erected, this could only be accomplished at great expense.

We know of one instance where a tank settled under water test to such an extent that it collapsed.

While these are extremes, they serve to illustrate the importance of first knowing the nature of the foundation base. Knowledge of geological formation or experience with other heavy structures in the same vicinity will often suffice, but if such knowledge is absent, soil borings are the safest means of investigation. There are many firms over the country well skilled in the art of making such borings. Soil bearing tests are now generally conceded to have little value other than to evaluate conditions at the tested level. The depth to which an applied load will produce significant stresses is in some measure proportional to the size of the loaded area. A large tank fully loaded will probe out weaknesses never revealed by a test on 1 or 2 sq ft.

Frequently the result of borings will indicate the desirability of limiting tank height rather than the expense of costly foundations.

*Chief Engineer, Chicago Bridge and Iron Company.

Assuming that bearing conditions have been determined to be adequate, the simplest form of foundation is a sand pad laid directly on the earth. All loam or organic material should be removed and replaced with suitable material, well compacted. Often a satisfactory fill material is available at the site. If not, bank run gravel is excellent and is readily compacted.

The grade for the tank should preferably be elevated sightly above the surrounding terrain to insure drainage. Sufficient berm should be provided to prevent washing and weathering under the tank shell. The berm width should be at least 5 ft. Weathering can be minimzied if the berm is subsequently protected with trap rock, gravel, or an asphaltic flashing.

It is customary to provide a crown of about 1 in. for each 10 ft of radius. On large tanks, the crown is sometimes limited to 6 in.

The sand pad should be at least 4 in. deep. The sand should be clean and free from corrosive elements. Care should be taken to exclude clay or lumps of earth from coming into contact with the bottom. Frequently the difference in potential between two types of earth will set up an electrolytic cell with resultant pitting.

Sometimes crushed rock is substituted for sand, but sand is easier to grade and usually more available.

While there is some difference of opinion, it is considered desirable to oil a sand grade. It is not satisfactory to merely pour oil on the surface because it will not penetrate or mix with the sand. Subsequent laying of the bottom will be difficult and welding is likely to start a fire. Oil and sand should be thoroughly mixed either in a concrete mixer or by "windrowing" with a grader or by hand. Only sufficient oil should be used to thoroughly wet the sand. Excess free oil will make subsequent working on the grade both difficult and hazardous.

If the sand cushion is placed on top of crushed rock fill, the rock should be carefully graded from coarse at the bottom to fine at the top. If this is not done, the sand will percolate down through the voids in the coarser rock.

An excellent base can also be obtained by substituting about 1½ in. of asphalt road paving mix for the sand cushion. This material is available from ready mix plants in many sections of the country. There is one precaution that must be carefully watched. After the material has set up, it is difficult if not impossible for the tank builder to correct inaccuracies by taking down the high and filling in the low spots. It is, therefore, most important that a paved tank grade be levelled with extreme accuracy under the shell.

Drainage is important both from the standpoint of soil stability and bottom corrosion. Good drainage should be provided not only under the tank itself, but the general area should preferably be well drained. Where the terrain does not afford natural drainage, proper ditching around a group of tanks may help to correct the deficiency.

Where suitable bearing soil is not available at the surface, but is available a reasonable distance below the surface, a ring wall foundation is indicated. The purpose of the ring is to confine the soil and prevent lateral movement. The ring wall is founded in the firm stratum and confines the weaker materials. Totally inadequate material should be removed and replaced with well compacted fill.

Many tank owners use ring wall construction as standard even when soil conditions do not indicate its use. There are a number of advantages in this practice that may well compensate for the added cost. The incidental advantages of the ring wall are neat appearance, an excellent foundation for the tank shell, the elimination of washing and weathering of berms, and the exclusion of surface water running into the grade.

We recommend that ring walls be so proportioned that the unit soil bearing at the level of the bottom of the wall is the same under the concrete as under the confined soil. This can be accomplished and will encourage uniform settlement of the foundation as a whole.

Assuming the tank shell to be centered on the wall, and earth to weigh 100 lb and concrete 140 lb per cubic foot, the thickness of the concrete wall may be determined from the following formula:

$$\text{Thickness of wall in inches} = \frac{24\,W}{qH - 80h}$$

Where:

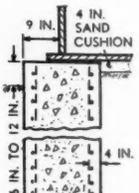
W = weight of metal in shell and roof supported on the ring wall, lb per ft of circumference.
H = height of tank shell, ft
h = height of ring wall, ft
q = weight of stored product lb per cu ft

In no case should the ring wall be less than 8 in. thick.

On tanks of relatively small diameter, the above formula will result in ring walls less than 8 in. thick, in which case the 8 in. minimum should be used as the closest approach to the desired ideal.

Where a ring wall is used, it should

Design of ring wall for 150 ft diam by 48 ft floating roof tank storing gasoline



W = steel weight on wall = 1320 lb per ft.
H = height of shell = 48 ft.
h = height of ring wall = 5 ft (assumed 4 ft frost line and 1 ft above grade)
q = weight of stored product = 45 lb per cu ft.

$$T \text{ (thickness of wall)} = \frac{24W}{qH - 80h} = 18 \text{ in.}$$

Horizontal pressure on ring = 5 X 0.3 [(62.5 X 48) + (100 X 2.5)] = 4875 lb per ft of wall.

Total hoop tension = PR = 4875 X 75 = 366000 lb.

$$\text{Required area of hoop steel} = \frac{366{,}000}{20{,}000} = 18.3 \text{ sq in.}$$

Use 24 bars 1 in. diam.

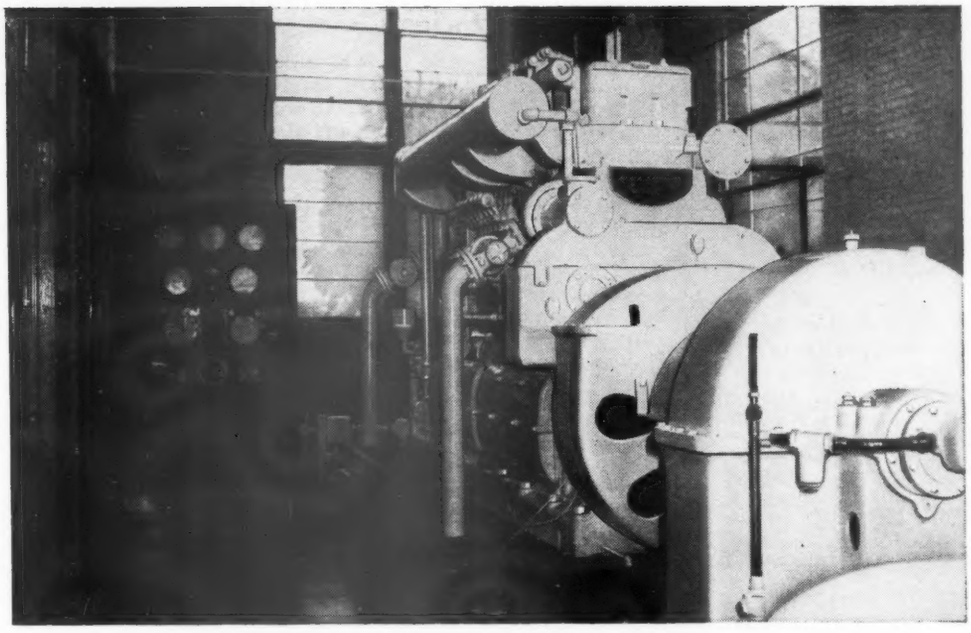
Notes

Ring wall to be founded below frost line.

Note that weight of stored product was used in determining T, whereas weight of water was used in determining reinforcing steel. It is believed that settlement is a factor of time as well as loading, and that in most cases the long term loading is more significant than the temporary water load under test. On the other hand the hoop tension due to water test load must be taken into account to avoid cracking of wall.

Where the characteristics of the confined soil are known, the designer should use the correct ratio between vertical and horizontal pressures rather than the safe limit of 0.3 used above.

For the shallow wall illustrated, the hoop tension was assumed uniform from top to bottom of wall. For high walls, the increase in lateral pressure with depth would require closer steel spacing at the bottom than at the top.



21,716 hours without forced shutdown

...and still going strong

that's the record of this Alco Diesel Engine at Barnett Station of Shell Products Pipe Line

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"The unit operates 24 hours a day and is never shut down except for the annual routine inspection and overhaul. . . . Not only have we boosted capacity of this line 15%, but operating and maintenance costs have been much reduced."

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Such power and performance can be yours, too, if you install Alco Diesel Engines to meet your pipe line pumping requirements. Your nearest Alco engineer will be glad to help. Call him today at sales offices in New York, Beaumont, Chicago, Cleveland, Houston, Kansas City, San Francisco, Schenectady, St. Louis.

SPEED Vs. WEAR

Remember, since piston speed and journal travel per minute are both almost the same in medium speed and slow speed engines, wear is equivalent as well. Not only do you get unequalled dependability with Alco Diesels—you get long wear and low maintenance costs, no matter how difficult the service conditions.

ALCO DIESELS

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AMERICAN LOCOMOTIVE COMPANY

be reinforced circumferentially to resist the hoop stress resulting from lateral pressure of the confined earth. Because soil conditions are rarely known in advance, it is our practice to design such walls on the basis of a lateral pressure equal to 0.3 of the combined liquid and earth vertical pressure. For shallow rings the vertical load contributed by the earth is small, but on deep walls it can become important.

If there are openings in the wall, the reinforcing must be carried around such openings to preserve the continuity of the hoop action. Nominal vertical steel is normally provided primarily for convenience in placing hoop steel.

Through the years there has been considerable discussion of the merits of placing the tank shell on the concrete versus placing the tank entirely within the ring wall. For many years we contended that the tank should not rest on the wall. It was feared that if settlement was greater within the wall than under the wall, failure of the bottom could occur.

On a carelessly prepared grade, this could happen and has happened. It has been our observation, however, that hundreds, if not thousands, of tanks have been successfully erected on ring walls. There are distinct advantages to so doing. It gives the erector a better base on which to build and there is less danger of subsequent shell settlement and distortion. The ring wall is not only founded on better soil than exists near the surface, but there is no danger of erosion under the shell.

We have, therefore, changed our opinion and now recommend ring wall construction with the tank shell resting on the wall, provided the following precautions are taken:

1. Proportion the ring wall so that soil pressures under the entire tank and wall are equal at the level of the wall base. The base of the wall should be below frost line.

2. Pour the ring wall against undisturbed earth without forms if possible. If this is not possible, see to it that backfill both inside and outside the wall is thoroughly tamped in place. This is particularly important during cold weather when fill material may be frozen. If this is not conscientiously done inside the wall, serious settlement along the wall can damage the bottom.

3. The top of the ring wall must be level. This point is frequently overlooked. It is not generally realized what large shell deformations can arise from relatively small differences in ring wall elevation. If the wall is out of level, the erector has no choice other than to erect on shims, which involves the placing and maintenance of grout. Experience has shown that it is possible to insist on and obtain accurately levelled walls. A desirable criterion is that the wall shall be level within $\frac{1}{4}$ in. (plus or minus $\frac{1}{8}$ in.) in one plate length (about 34 ft), and that no two points on the wall shall differ in elevation by more than $\frac{1}{2}$ in. (plus or minus $\frac{1}{4}$ in.). This may sound unduly restrictive, but it can be attained and will pay dividends.

In some cases, several layers of heavy asphalt felt roofing are placed on top of the ring wall under the edge of the tank. This practice has merit in that it seals off the periphery. The bottom joint breakdowns or backup strips settle into the felt and thus the effect of point bearing at bottom joints is minimized.

There are, of course, many pitfalls to be avoided in grade construction. If possible, always avoid situations where a tank rests partly on cut and partly on fill. If it cannot be avoided, see to it that the fill is of a readily compactible material and that it is well compacted. Be sure the fill is retained against lateral movement either by an adequate berm or a concrete ring.

The same caution applies to locations where rock occurs near the surface. Be sure the rock is under the entire tank and that the earth overburden is reasonably uniform in depth. Frequently rock strata will end abruptly and a good criterion is to place tanks so they are entirely over rock, or entirely off of rock.

Where soil conditions are such that none of the simpler foundation types are adaptable, piled foundations or other special types will require individual consideration for each case.

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Gas Lines Under Construction Total 7618 Miles

Current construction of 7618 miles of new natural gas pipe lines involving expenditures of $630,000,000, will bring new or additional benefits this year to millions of homes and thousands of industries in 125 cities of 50,000 or more population in countless neighboring communities.

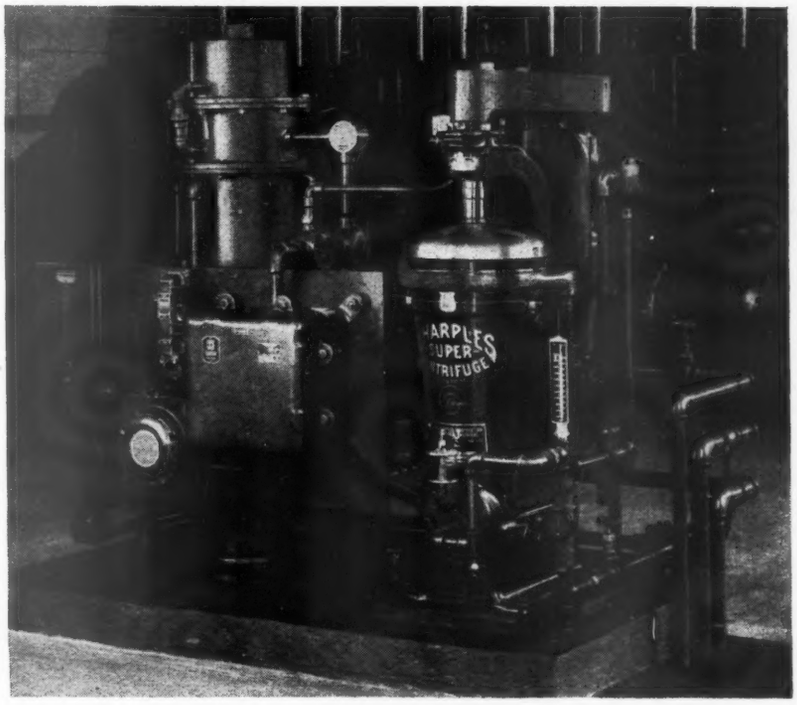
In addition to construction now under way, as authorized in 1950 by the Federal Power Commission, the fourth annual pipe line survey of the Gas Appliance Manufacturers Association also reveals that major applications involving an additional 15,866 miles of pipe line, to cost an estimated $943,640,000, awaited hearing and disposition by the commission on January 1.

"The growth of the natural gas industry is without parallel," H. Leigh Whitelaw, managing director of GAMA, said in releasing the survey. "Pipe lines have made it possible to transport natural gas from the producing fields to cities more than 2,500 miles away. Today no major city is beyond the reach of this vital, low-cost fuel.

"Latest expansion, assuring a steady gas flow to millions of additional homes and industrial plants, now brings the pipe line aggregate to a total of 296,000 miles, including field and gathering lines, 69,000 more than the combined mileage of all U. S. railroads."

Whitelaw said that assurances of adequate supplies of recoverable natural gas encouraged American capital to embark on the industry's multi-billion-dollar program of construction. Despite a rapid rise in gas use by residential and industrial consumers during the last five years, new gas reserves each year have exceeded the annual rate of usage.

cut DIESEL FUEL costs with the SHARPLES PIPE LINE CRUDE purifying system



A new, continuous centrifugal oil purifying and fuel handling method that converts pipe line crude into high quality diesel engine fuel has been designed by THE SHARPLES CORPORATION and is operating successfully in a number of leading pipe line pumping stations.

here's the story in brief!

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- The high efficiency centrifuge produces a non-cratering, low ash content fuel that eliminates cratering on fuel injection nozzles; assures complete combustion and maintains highest engine efficiency.
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- Operation is continuous and automatic; minimum attendance is needed; cleaning time is reduced to 15 minutes required only once a week. Purification and fuel costs automatically drop.
- Easily installed at low cost, the unit is readily piped into your pumping station.

You can take advantage of the economies of the Sharples System for your own Pumping Station — your inquiry will be given our prompt attention.

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To obtain more information on products advertised see page E-33

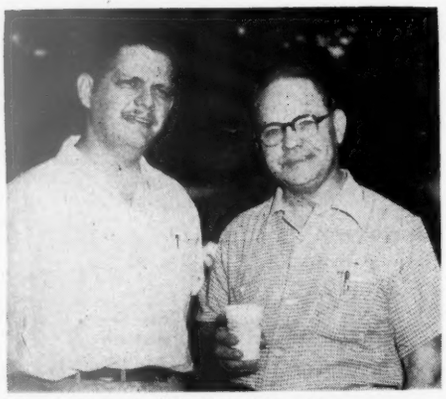
PICTORIAL

Photos taken at the Products Pipe Line Technology Conference of the API in Atlanta, Georgia.

J. R. Ellis, Sunray Pipe Line Company; L. R. Williams, Pure Oil Company; L. F. Scherer, Texas Pipe Line Company; Dean Glass, Pure Oil Company; Alex M. Erganian, Pipe Line Service Corporation.

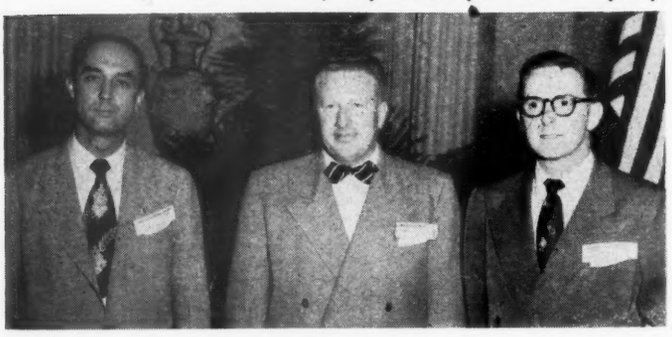
L. R. Dickinson, Socony-Vacuum Oil Company, and L. A. Baldwin, Johns-Manville.

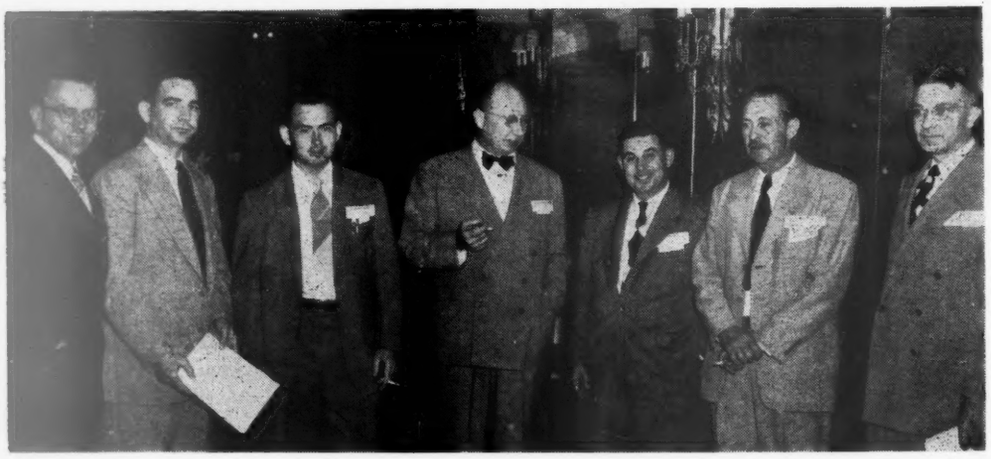
E. W. Lawlor, Pittsburgh Coke & Chemical Co.; Jack H. Webber, Kaiser Steel; C. C. Keane, Great Lakes Pipe Line Co.; Warner Lewis, Warner Lewis Company.



W. H. Morris, Sinclair Pipe Line Company, and A. C. Wilkinson, Continental Pipe Line Company.

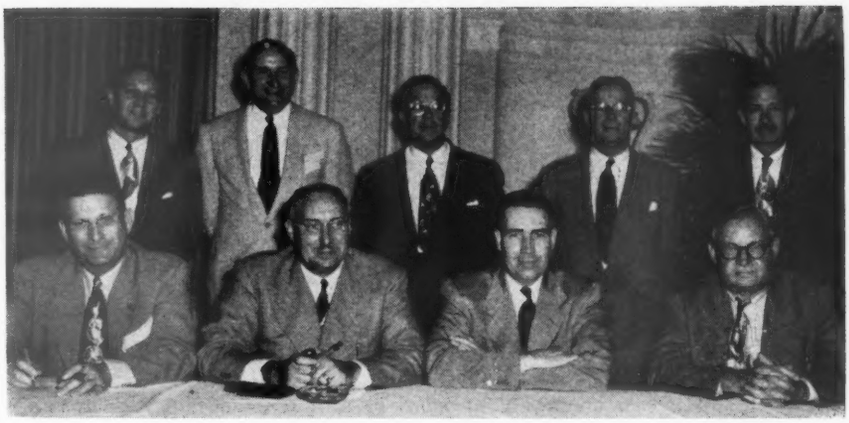
Three of the speakers: H. C. Van Nouhuys, Southeastern Pipe Line Company; Earl Unruh, Sinclair Pipe Line Company; Allen Baxter, Keystone Pipe Line Company.

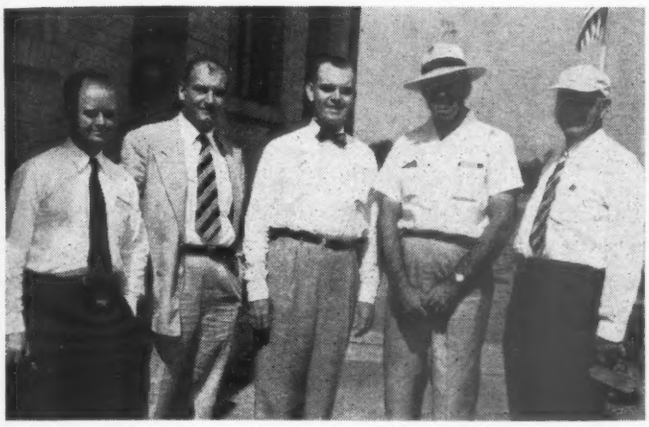




F. C. Whiteside, Continental Pipe Line Company; D. A. Roach, Phillips Petroleum Company; Fred Crandall, Phillips; D. J. Condit, The Condit Company; Roland Poinsett, United Centrifugal Pumps; J. W. Boyd, Phillips; D. L. Rankin, Standard Oil.

One session was devoted to questions and answers. These composed the panel of "experts": Front row: J. S. Hendrickson, Sinclair Pipe Line; L. F. Scherer, Texas Pipe Line; H. R. Hoyt, Great Lakes; F. Armstrong, Plantation. Back row: M. L. Barrett, Shell Oil Company; L. R. Williams, Pure Oil; J. G. Norton, Magnolia; W. S. Schmidt, Keystone Pipe Line; J. W. Boyd, Phillips Petroleum.



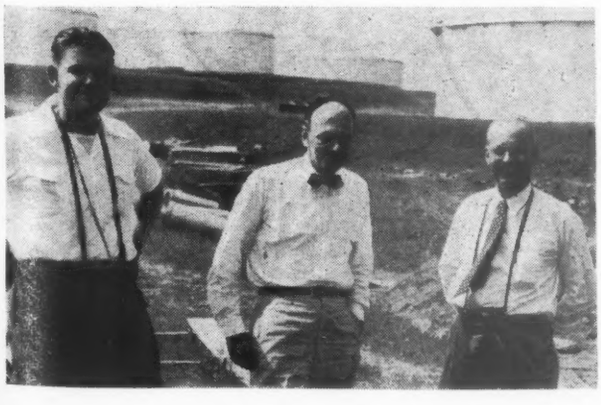


R. P. Hamilton, Southeastern Pipe Line Company; A. B. Hannah, Plantation Pipe Line Company; Harold Radcliffe, Tuscarora Oil Company; Lewis Misner, Plantation; John deGroot, Tuscarora.

W. G. Hortsman, Plantation Pipe Line Company, and D. L. Rankin, Standard Oil (Ind.)

E. J. Liggett, Johns-Manville, and E. L. Rolfs, Crutcher-Rolfs-Cummings.

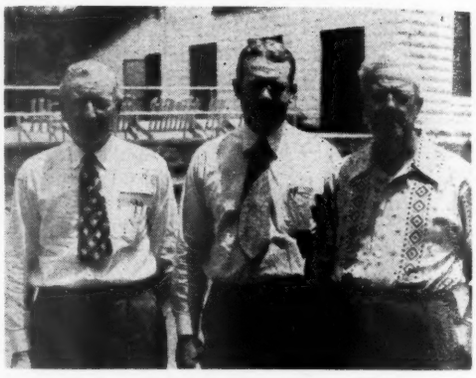
C. W. Hubbell, Phillips Petroleum Company; H. E. Fisher, Service Pipe Line Company; J. R. Shipley, Standard Oil Company.



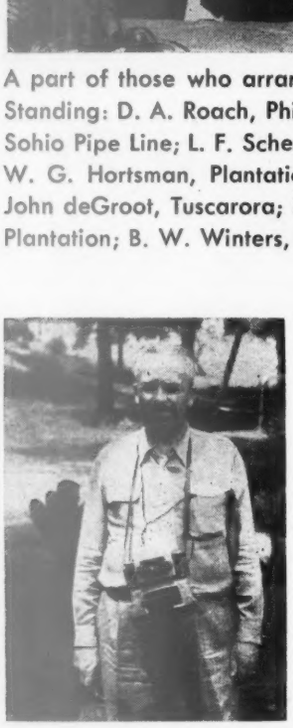
Left, Carl Peterson, Jr., Socony-Vacuum Oil Company; T. L. Opie, Socony-Vacuum; D. P. Dugan, Tuscarora.

Right, John deGroot, Tuscarora Oil Company, and B. W. Winters, Southeastern Pipe Line Company.

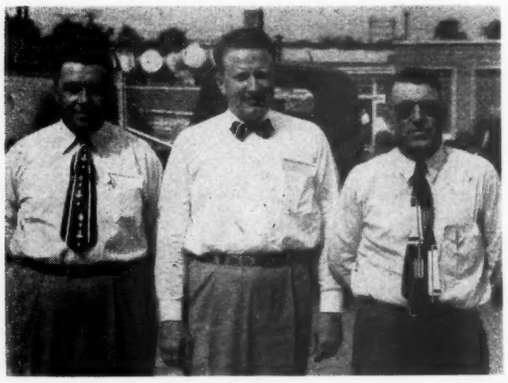
A part of those who arranged the meeting and some of the speakers. Standing: D. A. Roach, Phillips; M. J. Dabney, Plantation; J. P. West, Sohio Pipe Line; L. F. Scherer, Texas Pipe Line; H. E. Dischinger, Shell; W. G. Hortsman, Plantation; Allen Baxter, Keystone. Seated: John deGroot, Tuscarora; S. S. Smith, Shell; Charles R. Younts, Plantation; B. W. Winters, Southeastern Pipe Line Company.



R. T. Scott, Standard Oil; J. R. Wright, Magnolia Pipe Line Company; J. G. Norton, Magnolia, snapped while waiting for lunch to be served at Lithia Springs during station tour.



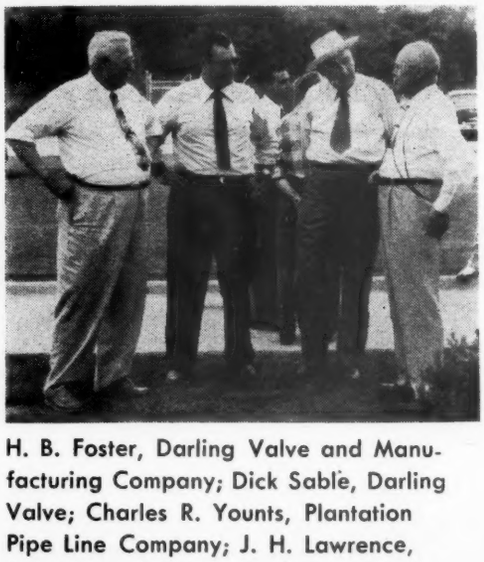
Harry K. Phipps, Socony-Vacuum Oil Company, taken at Lithia Springs. Harry was doing some camera work himself.



J. D. Maxey, Earl Unruh, and Lewis B. Moon, all of Sinclair Pipe Line Company, immediately before boarding bus at Southeastern's Chattahoochee station at end of field tour.

Herb Fisher, Service Pipe Line, and Dr. Ivy Parker, Plantation Pipe Line, discuss some features of Plantation's Bremen station during tour.

R. H. Lynch, Keystone Pipe Line Company, and H. H. Anderson, Shell Pipe Line Corporation. Lynch was elected chairman of products pipe line group for coming year.



H. B. Foster, Darling Valve and Manufacturing Company; Dick Sable, Darling Valve; Charles R. Younts, Plantation Pipe Line Company; J. H. Lawrence, Southeastern Pipe Line Company.

R. P. Hamilton, Southeastern Pipe Line, and J. W. Meehan, Pure Oil Company. Joe might be posing as a testimonial for that well-known soft drink.

Koppers West Coast Plant To Make Coal-Tar Enamels

Initial West Coast production of Bitumastic coal-tar pipe line enamels will get under way in the fall of 1951 at the new Fontana, California, plant of Koppers Company, Inc., Fred C. Foy, vice president and general manager of the company's Tar Products Division, has announced.

This new plant, situated on a 158-acre site near the large Kaiser Steel Company works, will be the first plant to produce coal-tar base pipe line enamels on the West Coast and will make greatly increased supplies of these materials available to the western market. Coal-tar roofing pitch also will be manufactured at the new plant.

The new installation at Fontana will be Koppers 58th plant and the 25th to come under the operation of the company's Tar Products Division.

Upon request, Koppers field servicemen will assist pipe line contractors in the West Coast area in field preparation and application of materials.

Millard K. Neptune Heads Platte Pipe Line Company

At a meeting of the board of directors of the Platte Pipe Line Company held in Chicago, Millard K. Neptune of Washington, D. C., was elected president. He succeeds H. L. Phillips, vice president and director of the Sinclair Oil Corporation and president of the Sinclair Oil and Gas Company, who has been acting as interim president of the Platte Pipe Line Company since its inauguration August 29, 1950.

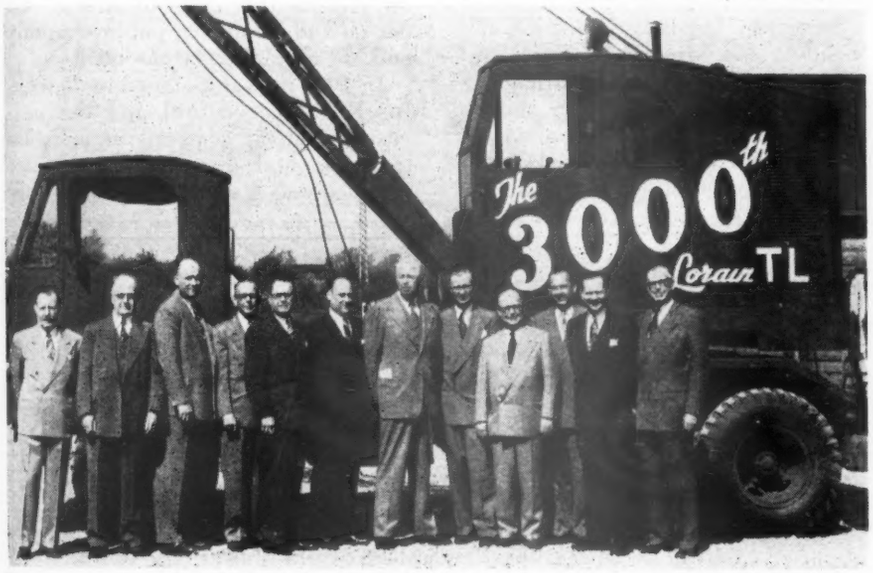
The Platte Pipe Line Company was organized by five major oil companies to construct and operate a 20-in. crude oil pipe line extending from the Rocky Mountain fields to the Wood River area in St. Louis. This line, now under construction, when completed will be approximately 1080 miles long. Due to the elevation of its main line station at Casper, which is slightly more than 5000 ft above sea level, only two pump stations will be required to provide daily delivery in excess of 70,000 bbl of crude oil at Wood River. With the installation of additional pump stations, the lines delivery capacity can be increased to about 150,000 bbl daily.

Millard K. Neptune

This line when completed will provide a much needed additional outlet for the Rocky Mountain area. In addition to serving refineries in the St. Louis area through connections with pipe lines from the southwest, it will provide an additional supply of crude for major refining centers in the middlewest.

Neptune, a veteran oil man, was assistant director of production, Petroleum Administration for Defense, prior to joining the Platte Pipe Line Company. He is a graduate of the Law School and the College of Engineering, University of Oklahoma. He joined the Phillips Petroleum Company in 1933 and after serving with the Petroleum Administration for War during World War II, became assistant manager of Phillips' operations in Venezuela. In July, 1948, he joined the Continental Oil Company as manager of the foreign department, and served there until last February when he joined the Petroleum Administration for Defense.

The Platte Pipe Line Company was organized by Continental Oil Company, The British-American Oil Company, Ltd., The Ohio Oil Company, The Pure Oil Company, and Sinclair Oil Corporation.



Lorain personnel, left to right: C. S. Weber, advertising manager; R. B. Miller, secretary-treasurer; W. J. Schmittgen, superintendent of TL plant; R. H. Zeilman, chief engineer; A. C. Lundgren, director of purchases; G. A. Gunther, assistant general sales manager; A. W. Smythe, vice president and general manager; W. V. Clark, controller and assistant treasurer; M. B. Garber, director of sales; J. T. Cushing, general sales manager; W. J. Allaback, plant manager; H. L. Reynolds, assistant secretary-treasurer.

3000th Lorain-TL Built Goes to Corps of Engineers

The Thew Shovel Company, Lorain, Ohio, recently shipped the 3000th Lorain TL Series shovel-crane. No. 3000, a 10-ton Moto-Crane, one of a number built for the Army Corps of Engineers, is part of orders for Lorains from the armed forces that total more than $19,000,000 so far. This series was an entirely new post-World War II development by Thew in the ½-yd. and ¾-yd classes as a shovel and 6 to 15 ton classes as a crane. Its basic design was different inasmuch as it was designed for so-called "packaged-component assembly," which simplifies maintenance and servicing.

The Lorain TL-Series is made as a crawler, Moto-Crane (as illustrated) or as a self-propelled machine and is convertible to shovel, crane clamshell, hoe, or dragline. Other and previously built series in the Lorain line are in 1-yd, 1½-yd, 1¾-yd, and 2-yd with lifting capacities up to 45 tons.

Oral Argument Scheduled In Phillips Case

The Federal Power Commission, acting to speed final decision in the Phillips Petroleum Company jurisdictional proceeding, has ordered the intermediate decision procedure omitted and has scheduled an oral argument for July 9 in Washington, D. C.

The action, requested by the FPC staff counsel and concurred in by all parties in the proceeding, means that the case will be decided directly by the commission without the filing of an intermediate decision by the presiding examiner.

More Oil Handled; Revenues Up, 1951

Transportation revenue and the number of barrels of oil originated on line and received from connections, as reported by large oil pipe line companies subject to the jurisdiction of the Interstate Commerce Commission, are shown below for the first quarter of the years 1941-1951. In the 1951 period both the volume of oil handled and the transportation revenue exceeded that of any corresponding period for which records are available. (The first quarterly data cover the year 1938.) The traffic volume for the first quarter of 1951 increased 25.9 per cent over that of 1950 and the revenues were up 26.5 per cent. In comparison with returns for the 1941 period, the increases are 124.2 and 114.7 per cent, respectively.

The results of the operations of the "Big Inch" and "Little Inch" (government-financed pipe lines) during the war years are not included in the figures in the table as these carriers did not report to the ICC during the war and were subsequently converted to natural gas lines. The larger proportion of oil transported by the "Big Inch" line during the war, however, was originated by carriers reporting to the ICC.

First quarter	Transportation revenues*	Number of barrels of oil originated on line and received from connections*
		Thousands
1941	$ 53,620,345	328,029
1942	53,127,772	381,211
1943	58,971,252	429,253
1944	69,809,852	530,992
1945	70,770,536	553,311
1946	64,557,635	490,806
1947	68,717,486	522,717
1948	80,196,660	606,045
1949	84,500,886	604,090
1950	91,043,251	584,349
1951	115,137,360	735,507
Per cent increase:		
1951 over 1941	114.7	124.2
1951 over 1950	26.5	25.9

*Based on quarterly reports of oil pipe lines having revenues of more than $500,000 per annum.

W. T. Stevenson Named President Texas Gas

W. T. Stevenson has been elected president of Texas Gas Transmission Corporation, it is announced by the company's board of directors.

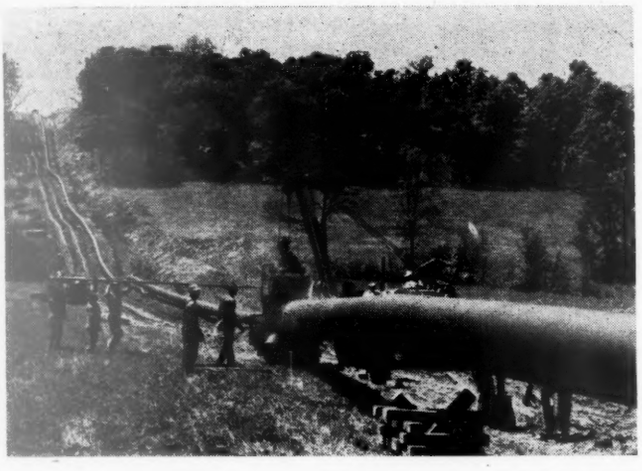
J. H. Hillman, Jr., formerly president and chairman of the board, will continue as chairman of the board.

Stevenson has been executive vice president and director of Texas Gas since the company was formed in 1948. He was also an officer and director of the two predecessor companies of Texas Gas, Kentucky Natural Gas Corporation and Memphis Natural Gas Company, which were merged with Texas Gas in 1948.

W. T. Stevenson

He was introduced to the natural gas industry in 1926 when he joined the Kansas City office of Arthur Andersen and Company, public accountants, to specialize in gas utilities.

In 1928 he was assigned to do work for Kentucky Natural and the next year joined the company as assistant treasurer and director. He is also president of Western Kentucky Gas.



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Plains Pipe Line Company Organized

Formation of the Plains Pipe Line Company, owned jointly by Phillips Pipe Line Company and Cities Service, has been announced by K. S. Adams, chairman, and Paul Endacott, president, of Phillips Petroleum Company, and A. W. Ambrose, president of Cities Service Oil Company.

This new company, owned 50 per cent by Phillips and 50 per cent by Cities Service, will operate a new crude oil pipe line and gathering system in the Spraberry trend in West Texas. Construction is well underway. The lines will extend through the prospective territory of Glasscock, Midland, Reagan, and Upton counties.

Officers of the new company are D. M. McBride, president; B. F. Stradley, vice president and treasurer; W. H. Wallace, vice president and manager; C. S. Mitchell, vice president; Paul J. Parker, secretary and assistant treasurer; W. F. Martin, assistant secretary and assistant treasurer; T. V. Stevens, assistant treasurer; Lloyd Lynd, assistant treasurer; R. E. Arnold, assistant secretary; F. B. Plank, assistant secretary; and J. F. Kinslow, assistant secretary.

New Transco building, Houston.

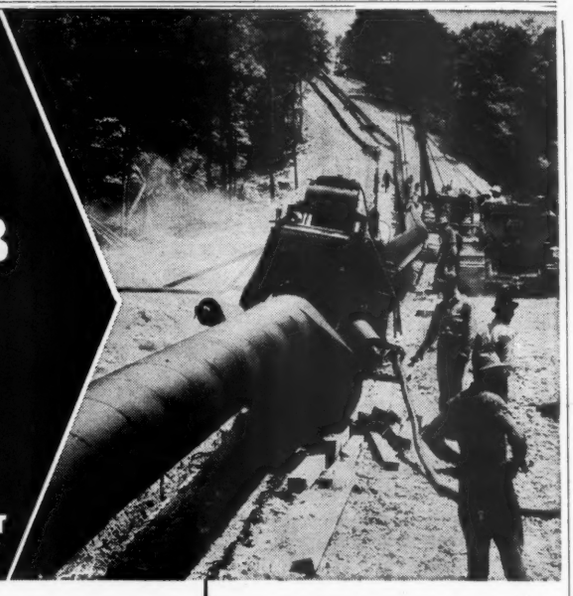
Transco Dedicates New Office Building

The Transcontinental Gas Pipe Line Corporation celebrated the second anniversary of the groundbreaking for its 1840-mile Texas to New York City pipe line with the opening of its new home office building at 3100 Travis in Houston, Texas.

The building is brick faced with Austin limestone and has no exterior windows. An outstanding feature is the gas fired absorption air-conditioning system, the largest in Houston.

The 300 ft tower constructed at the rear of the building provides the Houston offices with a microwave system, which parallels the entire 1840-mile pipe line and links them with their gas control station in Linden, New Jersey, 19 compressor stations along the line, and mobile field crews operating from these stations by car or company plane. Transcontinental's microwave system is the longest in the United States. The tower is one of 58, ranging from 50 to 350 ft in height depending on location and terrain, which stretch across 12 states, from the Rio Grande Valley of Texas to the City of New York.

WRAP UP THE JOB WITH RUBEROID IMPERIAL ASBESTOS PIPE LINE FELT



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That's why Ruberoid asbestos pipe line felt was chosen as the protective wrapping for the new 26" gas line from Kentucky to Buffalo, N. Y. Built by the Tennessee Gas Transmission Company, this gas line is assured of long-range economy in maintenance by the enduring performance of Ruberoid Imperial Asbestos Pipe Line Felt.

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PIPELINE PERSONALS

G. A. Welsh

C. A. L. Walker

G. A. Welsh has been appointed traffic manager of Great Lakes Pipe Line Company, Harry Moreland, president of the company, announces. Welsh formerly was assistant to the traffic manager.

Retirement of **C. A. L. Walker,** a vice president of Great Lakes, was announced simultaneously with notice of the advancement of Welsh. Walker has been an administrative and executive member of the pipe line company since its organization in July, 1930, first as traffic manager and in recent years as a vice president. He relinquished responsibilities in company management upon retirement but is continuing with Great Lakes as a consultant.

J. B. Tietze, Phillips Pipe Line Company, Bartlesville, Oklahoma, is a new member of The Pipe Liners Club of Tulsa. Other recent new members are **A. L. Fillenwarth,** Great Lakes Pipe Line Company, Tulsa, and **William H. Case,** Gulf Refining Company, Tulsa.

R. G. Follis has been elected chairman of the board of Trans-Arabian Pipe Line Company. **W. F. Moore,** president of Arabian American Oil Company, was elected to the Tapline board and named as a member of the company's executive committee.

Walter F. Rogers, Gulf Oil Corporation, Houston, Texas, has been named general chairman of the 1952 Conference and Exhibition of the National Association of Corrosion Engineers, to be held in Galveston, Texas, in March. **Robert L. Bullock,** Interstate Oil Pipe Line Company, Tulsa, Oklahoma, is the technical program chairman; **Jack W. Harris,** Cameron Iron Works, Houston, exhibition chairman, and **Charles G. Gribble, Jr.,** Metal Goods Corporation, Houston, local arrangements chairman.

Tom Bain, industrial engineer with the Lone Star Gas Company of Dallas, Texas, has joined the Atlantic Refining Company staff to serve as chief engineer in constructing its 300-mile gas line in Venezuela. The line will extend from the interior to the coast, servicing Caracas and Maracaibo industrial plants, and will utilize natural gas now being flared.

Graydon A. Scrafford has been appointed vice president and general manager of The Buckeye Pipe Line Company with offices at Lima, Ohio.

James W. Dunham, vice president of National Cylinder Gas Company, Chicago, was elected president of the International Acetylene Association at the annual business meeting held during this organization's recent annual convention in Montreal, Quebec. Dunham had served as vice president for the year 1950.

F. W. Hench, president, American Oxygen Service Corporation, Harrison, New Jersey, was elected vice president of the association. **E. V. David,** assistant manager of the technical sales division, Air Reduction Sales Company, New York, was re-elected treasurer. **H. F. Reinhard** was re-elected secretary.

Dunham was born in Danvers, Massachusetts, and received his primary education in the public schools of Brookline, Massachusetts. He studied chemical engineering at Massachusetts Institute of Technology, receiving his B.S. degree in 1926. He started his business career as an engineer for the Keith Dunham Company after his graduation from college. He continued with its successor company, National Cylinder Gas Company, of which he is presently vice president, director, and chairman of the executive committee. He is also a director of the Midwest Carbide Corporation, Tube Turns, Inc., and the Pennsylvania Forge Corporation.

B. C. Adams, Jr.

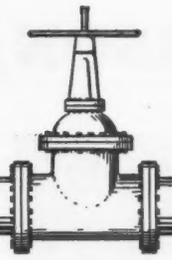
Edward T. Bowers

B. C. Adams, Jr., has been elected vice president of the Texas Gas Transmission Corporation in the company's gas supply department. Adams has served as assistant to the executive vice president since he joined the company in May, 1950. In addition to his duties of negotiating and contracting for natural gas reserves, he will continue as vice president of Louisiana Natural Gas Corporation and Texas Northern Gas Corporation, gas-gathering subsidiaries of Texas Gas in southwestern Louisiana.

Prior to joining Texas Gas, Adams was, for two years, a vice president of Trunkline Gas Company. During World War II he served in the Petroleum Administration for War as chief of the Natural Gas Section. Previously, he had served as assistant to the president of Cities Service Gas Company in Oklahoma City, and assistant to the general superintendent of Oklahoma Natural Gas Company.

Edward T. Bowers has been elected comptroller of Texas Gas. He has been assistant comptroller of the pipe line company for the past year. He has served with Texas Gas and a predecessor company, Memphis Natural Gas Company, since 1940. During that time he held posts as auditor and assistant treasurer of Memphis Natural, and was secretary-treasurer of Southwest Gas Producing Co.

PIPE LINE PROJECTS



Texas Gas Outlines $45,300,000 Expansion Plan

Texas Gas Transmission Corporation, Owensboro, Kentucky, has before the Federal Power Commission plans for a $45,300,000 pipe line project that will bring more natural gas to defense industries and homes in seven Midwestern states and the Appalachian area.

The company asked the FPC to authorize a 600-mile pipe line expansion that would raise the company's daily delivery capacity by 240,000,000 cu ft to more than 900,000,000 a day.

The new supplies are destined for the company's present customers in Louisiana, Arkansas, Mississippi, Tennessee, Kentucky, Indiana, and eastern Illinois. Texas Gas also plans to increase sales by 95,000,000 cu ft a day to the Ohio Fuel Gas Company, a Columbia Gas System subsidiary, serving large communities throughout Ohio. Sales to Louisville Gas and Electric Company for Louisville, Kentucky, will be increased from 40,000,000 to 60,000,000 cu ft daily.

In addition, Texas Gas announced that 90,000,000 cu ft a day will be made available, on an interruptable basis, to the Tennessee Valley Authority at Johnsonville, Tennessee. This supply will enable TVA to meet growing power requirements of two Atomic Energy plants at Oak Ridge, Tennessee, and Paducah, Kentucky, as well as other industrial plants. The gas will be available to TVA when it is not required for firm customers in Memphis and the southern portion of the Texas Gas system.

The company told the FPC that throughout its territory and that served by the Ohio Fuel Gas Company, industrial development is being speeded, and that more natural gas is urgently required to meet the needs of plants and labor forces devoted to the production of defense material. To meet these needs, Texas Gas said, more pipe line capacity must be provided if severe future curtailment is to be avoided. The company noted that firm delivery capacity of its present 2400-mile pipe line system exceeds 660,000,000 cu ft a day.

Supplies for the new project will come from Texas Gas' gas-gathering subsidiaries in southwestern Louisiana, which will be connected to the company's main 26-in. line through a new 26-in. lateral, and from United Gas Pipe Line Corporation. A contract negotiated with United Gas calls for Texas Gas to receive up to 200,000,000 cu ft daily.

L. E. Ingham, vice president in charge of operations and engineering, testified that Texas Gas has on firm order 600-miles of 26-in. pipe line required for the project. He said a substantial portion of the balance of the material needed has been ordered, and that construction can begin within 60 days after FPC approval is received. Initial deliveries through the new facilities can begin early next year.

Included in the Texas Gas expansion program are the following:

1. Construction of 189-miles of 26-in. pipe linking gas-gathering subsidiaries in southwest Louisiana with the main Texas Gas line in the northeastern part of the state.

2. Construction of 412 miles of 26-in. pipe line along the company's present system from Louisiana to northern Kentucky, and addition of 18,580 compressor hp, including new stations near Shreveport, Louisiana, and Madison, Indiana.

Temporary Certificate Granted for Line

Mississippi River Fuel Corporation, of St. Louis, Missouri, has received temporary authorization from the Federal Power Commission to build additional natural gas facilities, including approximately 98 miles of transmission pipe line in Louisiana and Texas to enable it to draw upon two additional sources of natural gas.

Mississippi will build 98 miles of 18- and 16-in. pipe line from the California Company plant in Lincoln Parish, Louisiana, to the Woodlawn gas field in Harrison County, Texas, with an 11-mile, 10-in. lateral running southward to the Waskom field, also in Harrison County. In addition, the company will construct a gathering system in the Woodlawn field. Estimated cost of the facilities is $5,135,070, exclusive of the gathering system, which would be installed initially at an estimated cost of $489,147.

Ohio-Pennsylvania Projects Authorized

The Federal Power Commission has authorized The East Ohio Gas Company, of Cleveland, Ohio, and New York State Natural Gas Corporation, of New York City, to construct and operate natural gas facilities, including pipe lines in Ohio and Pennsylvania and a storage area in Pennsylvania.

The order authorizes New York State Natural to acquire the South Bend Storage area in Armstrong and Indiana counties, Pennsylvania, and to construct facilities necessary to utilize the area for the underground storage of natural gas. The company will also build a 77-mile, 20-in. line from the storage area to a point on the Ohio-Pennsylvania state line in Lawrence County, Pennsylvania; 17 miles of field lines, and a 12,000-hp compressor station in the storage area.

New York State Natural will acquire the storage properties from The Peoples Natural Gas Company, of Pittsburgh, Pennsylvania, and the additional gas to be made available through operation of the pool will be delivered to Peoples and East Ohio. The three companies are affiliates in Consolidated Natural Gas system.

The FPC order authorizes East Ohio to build a 65-mile, 26-in. line, which will connect with the line to be built by New York State Natural on the Ohio-Pennsylvania state line.

Total estimated capital cost of New York State Natural's project is $8,969,100, and East Ohio's line will cost an estimated $4,382,170.

Temporary Authority Granted Gas Line

The Federal Power Commission has granted temporary authorization to New York State Natural Gas Corporation, of New York City, for the construction and operation of a 39-mile natural gas pipe line in Pennsylvania and New York.

The 20-in. line, which the company said will help it meet increasing demands of present customers, will extend from New York State Natural's state line compressing station in Potter County, Pennsylvania, to the boundary line between Livingston and Monroe counties, New York.

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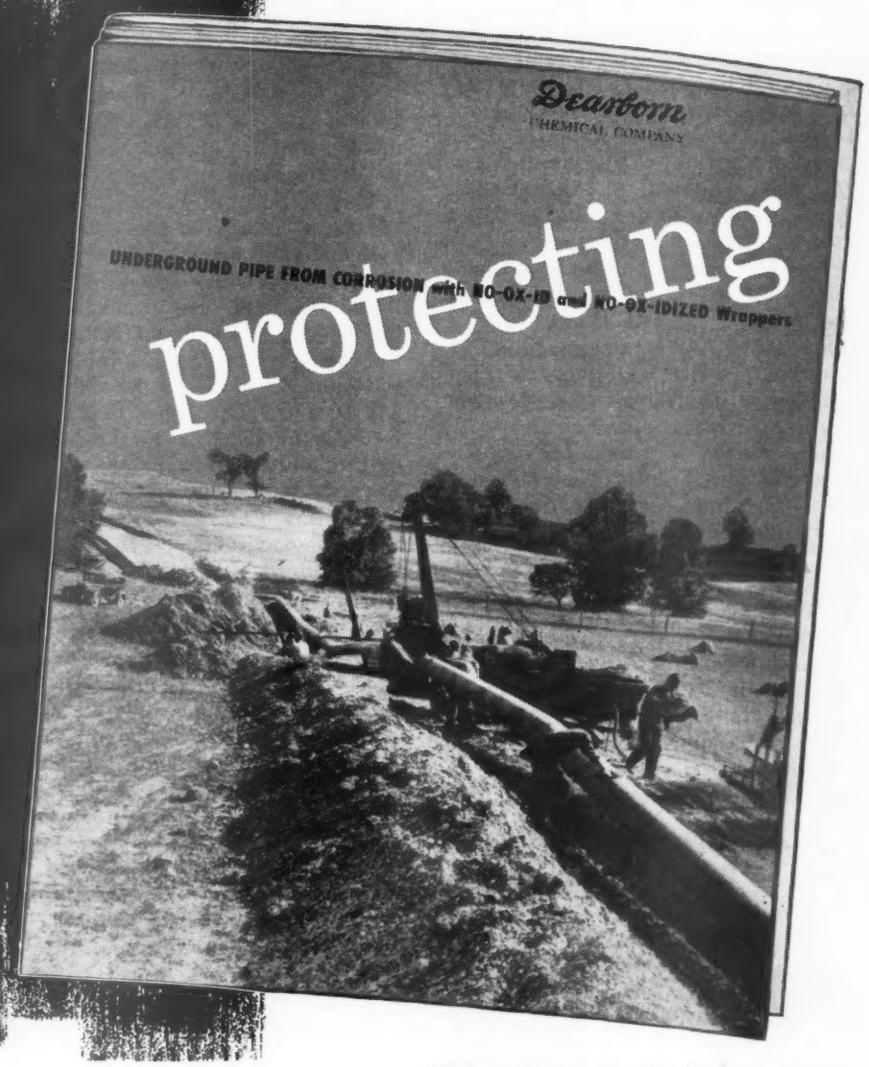

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To obtain more information on products advertised see page E-33

Carolinas to Have Increased Gas Service

The Federal Power Commission has authorized the construction of additional pipe line facilities to bring natural gas into the Carolinas, and has directed Transcontinental Gas Pipe Line Corporation, of Houston, Texas, to supply a total of 24,163,000 cu ft of gas per day to certain companies and communities in that area.

The FPC action authorizes Carolina Natural Gas Corporation, of Charlotte, N. C., and Public Service Company of North Carolina, Inc., of Gastonia, North Carolina, to construct pipe line systems to serve markets in North Carolina.

In addition, the commission allocated gas from Transcontinental's system to Carolina Central Gas Company, of Hendersonville, North Carolina, and to the South Carolina cities of Laurens, Clinton, Newberry, and Blacksburg. Carolina Central will supply gas in Hendersonville.

Carolina Natural will build a total of 67.5 miles of line, consisting of two sales lateral systems each originating at a separate connection with Transcontinental's main line. One of these systems, the Hickory lateral, will serve Hickory, Newton, Conover, Granite Falls, Lenoir, Lincolnton and Statesville Brick Company, all in North Carolina. The other, the Lexington lateral, will serve Lexington and Thomasville, and the Cunningham Brick Company, also in North Carolina.

The commission's order allocates a total maximum of 3,235,000 cu ft of gas per day to Carolina Natural from the Transcontinental capacity.

Public Service was authorized to construct a series of five sales lateral systems, four originating at separate connections with Transcontinental's main line, and one connecting with the system of Piedmont Natural Gas Company, Inc., of Spartanburg, South Carolina. Total length of the system will be about 169 miles. Public Service was allocated a total maximum daily quantity of 16,385,000 cu ft of gas per day.

Carolina Central was allocated a maxium of 510,000 cu ft of gas per day; Laurens 1,279,000 cu ft; Clinton, 1,272,000 cu ft; Newberry, 1,184,000 cu ft, and Blacksburg, 298,000 cu ft.

The commission's order includes authorization for Piedmont Natural to build facilities to transport gas by means of its Greensboro-Burlington lateral for the account of Public Service. Piedmont will substitute larger pipe and construct a metering station.

Carolina Central will build 2.5 miles of line; Laurens will construct 19.5 miles of line; Clinton and Newberry will jointly build 49.6 miles of line; and Blacksburg will construct 1900 ft of line.

Estimated cost of constructing the various projects follows: Carolina Natural, $936,334; Public Service, $4,533,282; Piedmont Natural, $812,800; Laurens, $402,345; Clinton and Newberry, $970,000; and Blacksburg, $2,230.

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Transco to Install Delaware River Crossing

Transcontinental Gas Pipe Line Corporation, of Houston, Texas, has received temporary authorization from the Federal Power Commission for the construction of an auxiliary pipe line crossing of the Delaware River near Marcus Hook, Pennsylvania.

The project, estimated to cost $1,123,415, will include 7200 ft of 12¾-in. pipe and appurtenant valves, headers, and other necessary facilities. The new crossing will be installed adjacent to an existing crossing that was broken last winter by a ship dragging its anchor. Although the old crossing has been temporarily repaired, the company said the new auxiliary crossing is needed to provide assured adequate service to customers beyond the Delaware River.

Cities Service to Extend Pecos County Facilities

Extension of its gathering and transportation facilities into the Malicky and TCI fields of Pecos County, Texas, has been announced by Cities Service Pipe Line Company. Cities Service has been serving this area since discovery of the two fields almost two years ago. The company has been trucking most of the output of the fields to receiving tanks for delivery to the jointly-owned Texas-New Mexico pipe line system at the nearby Abell pump station.

The expansion program announced by Cities Service includes the construction of 13½ miles of 4-in. line, 18 battery connections, 4 field pump units and additional receiving tanks. Upon completion of the program, oil will be moved by Cities Service pipe line to the Abell station of Texas-New Mexico.

Production from the Malicky and TCI fields is slightly more than 1000 bbl daily from 47 wells, and 10 drilling rigs are running in the area.

FPC Denies Request For 172-Mile Line

The Federal Power Commission has denied an application of The Manufacturers Light and Heat Company, of Pittsburgh, Pennsylvania, proposing the construction of 172 miles of natural gas transmission line extending from prospective gas field in Clinton County, Pennsylvania, to an interconnection with the company's existing system in Washington County, Pennsylvania.

The commission, which found that there is no proved gas supply to support the proposed project, said that the company is relying upon discoveries to be hereinafter made in 33 untested domes near the route of the proposed line to supply the facilities.

Manufacturers' application asserted that the line was to be used to transport gas from wells in Pennsylvania to markets in Pennsylvania and asked the FPC to disclaim jurisdiction over the proposed construction and operation. At the May 8 hearing on the application, however, the company withdrew the jurisdictional question and its engineering witness testified that if the hoped for quantities of gas were transported through the line, part of it would be sold in Ohio.

The commission said that if the company desires to build the line and operate it in intrastate commerce, the FPC would have no jurisdiction. The commission also said that if an adequate supply of natural gas is subsequently discovered, it should not be difficult for the company to obtain the necessary FPC authorization.

Imperial Oil's Line to Be in Service in 1952

Major materials for Imperial Oil's products pipe line from Sarnia to Toronto are now on order and the line is expected to be completed and go into service in 1952.

The line will consist of about 125 miles of 12-in. pipe and some 60 miles of 10-in. pipe. It will deliver gasoline, diesel and furnace fuels, and gas oils from the Sarnia refinery to terminals in London, Hamilton, and Toronto. Initial throughput will be 28,000 bbl (980,000 gal) a day. Cost of the line will be about $9,000,000.

Company officials said the increased demand for these products could be supplied either by the pipe line or by building new tankers and extra storage tanks. The cost of moving petroleum products to the area served is about the same by either method. The decision to build the line was made because it will require less steel than the ships and tanks and will enable the company to make more flexible supply arrangements. Using tankers, the winter consumption of the various products would have to be estimated in advance and brought in and stored before the close of navigation. A pipe line has no closed season and products can be pumped through it as needed.

Present marine terminals at Toronto and Hamilton will be supplied by the new line but in London a suburban site for a new terminal has been selected to replace the existing plant. To supply Hamilton, two 6-in. take-off lines will run from Waterdown—about 6 miles distant—and for about a mile they will run under Hamilton Harbor.

An aerial survey of the line was completed some months ago and a tentative route traced on maps based on the aerial photographs. Then engineers went over the ground and changed the route to avoid such obstacles as water hazards and swamps. A detailed ground survey to locate the actual right-of-way, which in most cases is 50 ft wide, is now in progress.

Gulf Plans Construction Of Two Products Lines

Gulf Oil Corporation plans to construct a 10-in. products pipe line from Gulf's Lufkin station in East Texas to El Dorado, Arkansas, and a combination 10-in. and 8-in. products pipe line from Helena, Arkansas, to Nashville, Tennessee.

These lines, connecting with the 5-in. line extending from El Dorado to Helena, will handle refinery products from the Beaumont area to Nashville, with intermediate take-off points at Nacogdoches, Texas, Shreveport, Louisiana, and Memphis.

Pipe Lines to Six Gas Storage Pools Authorized

The Federal Power Commission has authorized The Ohio Fuel Gas Company, of Columbus, Ohio, to build pipe line facilities for the conversion of six natural gas producing pools in Ohio to storage service. The pools have an ultimate storage capacity of approximately 35.7 billion cu ft gas.

To convert the pools, Ohio Fuel will build about 74.2 miles of high pressure storage project pipe lines ranging in size from 3½ to 20 in.; construct a 47.5-mile 20-in. line from Benton Township in Hocking County to Columbus, and install an additional 8480 hp in compressor capacity at existing stations.

The producing pools are in the Benton storage area in Hocking County, the Knox storage area in Knox County, and the Weaver and Pavonia storage areas in Ashland County.

Ohio Fuel plans to begin construction as early in 1951 as material supplies and weather will permit, and to complete the project and place it in operation by November 1, 1952. Inputs into four of the storage areas are scheduled to commence this summer.

Total estimated capital cost of the facilities is $6,425,200.

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Montana-Dakota to Buy and Build Facilities

The Federal Power Commission has authorized Montana-Dakota Utilities Company, of Minneapolis, Minnesota, to acquire natural gas facilities of three companies operating in Montana and Wyoming, to construct interconnections between the properties and to build additional facilities.

Montana-Dakota will acquire and operate all the properties of the Billings (Montana) Gas Company and Big Horn Gas Company, of Basin, Wyoming, and part of the facilities of The Rocky Mountain Gas Company, of Casper, Wyoming.

The facilities to be purchased from Billings include a desulphurization and dehydration plant; a compressor station; an 88-mile line from the Garland, Wyoming, gas field to Billings, Montana; 22 miles of lateral and gathering lines; and the distribution systems in Billings, Laurel, Park City, Silesia, Joliet, Edgar, Fromberg, Belfry, and Bridger, Montana.

The Rocky Mountain Gas Company properties include 41 miles of line supplying gas at retail in Cowley, Lovell, and Powell, Wyoming, the distribution systems in those three communities, and a line extending from the Garland gas field to Lovell.

The Big Horn properties consist principally of a 74-mile line extending from the Little Buffalo Basin field in Hot Springs County, Wyoming, to Basin and Greybull, Wyoming, and approximately 13 miles of branch line in Hot Springs County.

Montana-Dakota plans to interconnect these facilities with the pipe line owned by Montana-Wyoming Gas Pipe Line Company and operated by Montana-Dakota, by constructing about 16 miles of line. Montana-Dakota also will build a compressor station consisting of two 330-hp units together with dehydration facilities in the Little Buffalo Basin field.

Estimated cost is $4,770,389 as of September 30, 1950, plus or minus book adjustments. The facilities to be built by Montana-Dakota are estimated to cost $708,774.

Gas Line Planned for Southern California

Southern California Gas Company, of Los Angeles, California, has asked the Federal Power Commission for authority to build a 35-mile natural gas pipe line extending into the Antelope Valley of Southern California.

The proposed line would be used to supply natural gas to Mojave, Lancaster, and Palmdale, in which Southern California now renders liquid petroleum gas service, and to Rosamond, which does not have any gas service.

Tennessee Gas Expansion Approved by FPC

The Federal Power Commission has authorized Tennessee Gas Transmission Company, of Houston, Texas, to carry out an expansion program designed to increase the daily design delivery capacity of its natural gas transmission system from 1,310,000,000 cu ft to approximately 1,395,000,000 cu ft.

The commission also authorized Tennessee and United Natural Gas Company, of Oil City, Pennsylvania, to construct facilities necessary to develop and utilize an underground storage area for natural gas in the Hebron field in Potter County, Pennsylvania. This storage project will increase Tennessee's peak day delivery capacity to 1,595,000,000 cu ft.

The facilities to be built by Tennessee include about 419 miles of 26- and 30-in. loop line along its presently authorized system; 142 miles of 24-in. new line; approximately 200 miles of various diameter lateral lines to be located throughout the system; 54,100 compressor hp at existing and previously authorized stations, and 21,120 hp in a new station at the Hebron field.

The new facilities will be used to transfer a daily delivery of 25,000,000 cu ft presently delivered in Tennessee's eastern rate zone to its northern rate zone for delivery to the account of The Manufacturers Light and Heat Company, of Pittsburgh, Pennsylvania; and to deliver an additional 15,000,000 cu ft each to Iroquois Gas Corporation, of Buffalo, New York, Equitable Gas Company, of Pittsburgh, and United Natural.

Tennessee plans to use the remaining 40,000,000 cu ft per day initially to provide a part of the 23,800,000,000 cu ft of cushion gas required for operation of the Hebron storage field. Tennessee expects to have all this cushion gas in the storage field by the end of 1953, and this 40,000,000 cu ft per day will then be available for sale on a firm annual basis.

In granting this request, the commission said that a finding could not be made at this time that the public convenience and necessity require the construction and operation of facilities north and east of the Hebron storage area, as no evidence was submitted as to whom this gas is to be sold, where it is to be delivered, or in what volumes it will be sold.

The commission therefore denied a portion of the facilities that Tennessee proposed to construct, including 162 miles of new line construction, 109 miles of loop line, and 3000 hp of additional compressor capacity.

Estimated cost of all the facilities proposed by Tennessee, including those authorized and those denied, is $94,869,000. The storage project, which will be paid for and owned jointly by Tennessee and United Natural, is estimated to cost $7,400,000. Authorization requires sale of up to 1,000,000 cu ft of gas daily to Republic Light and 3,519,00 to Clarksville.

Cities Service Gas Will Add Facilities

The Federal Power Commission has authorized Cities Service Gas Company, of Oklahoma City, Oklahoma, to construct new natural gas pipe line facilities, and to abandon others, in Kansas, Oklahoma, and Missouri.

The authorization, which involves two applications by Cities Service, includes the installation of a total of 13,080 hp at new and existing compressor stations on the company's system. Cities Service will install three additional 1600-hp units at its existing Hugoton station in Grant County, Kansas; build a new 6400-hp station near Greensburg, Kansas; construct a 1200-hp station near Welch, Oklahoma; and construct a 680-hp station near Pierce City, Missouri.

The three additional units at the Hugoton station and the new station near Greensburg will enable the company to increase the capacity of its line from the Kansas-Hugoton field to Kansas City, Missouri, and thus eliminate an anticipated firm curtailment of 20,290,000 cu ft on the peak day of 1951-52, and at the same time allow 39,710,000 cu ft of curtailable industrial demand to be served.

The remainder of the compressor facilities will increase the system capacity of the company's Springfield system from 46,400,000 cu ft per day to 52,830,000 cu ft. The Springfield system extends from Cities Service's Caney, Kansas, compressor station to Springfield, Missouri.

Estimated cost of the facilities covered in this application is $4,204,000.

The facilities covered in the other application authorized by the FPC include approximately 56 miles of 16, 10¾, and 3-in. pipe in Sedgwick, Harvey, and Labette counties, Kansas. These facilities, estimated to cost about $982,610, will provide increased capacity in the Wichita-Newton-Hutchinson, Kansas, area.

The facilities which Cities Service was authorized to abandon consist of approximately 192 miles of line, ranging from 2 to 12 in. in diam, in Reno, Sedgwick, Wilson, Harvey, Kingman, and Labette counties, Kansas.

The company said that maintenance and leakage have become excessive on most of the sections of line to be abandoned, and that operation of the old lines is no longer necessary.

Peoples Natural Files Supplementary Petition

The Peoples Natural Gas Company, of Pittsburgh, Pennsylvania, has filed a supplement to its October 19, 1950, petition for a declaratory order by the Federal Power Commission that the company either is or is not a "natural-gas company" by reason of any operations in which it is now engaged or proposes to engage.

The supplement sets forth plans for the construction of 25 miles of loop pipe line in Cambria and Blair counties, Pennsylvania, and 6 miles of line connecting with New York State Natural Gas Corporation's system in Westmoreland County, Pennsylvania. Total estimated cost of the 25 miles of line is $1,279,650, and estimated cost of the 6-mile section of line is $228,200.

The October 19 petition asked for the necessary FPC authorization in the event that the company is found to be a "natural-gas company" by reason of its present or proposed operations.

The operations referred to in the original petition included 36 miles of line in Cambria and Somerset counties, Pennsylvania, connecting Peoples' system with facilities of Texas Eastern Transmission Corporation. Petition also described 15 miles of line now under construction in Beaver County, connecting with Tennessee Gas Transmission Company's facilities.

Applications of Three Gas Companies Dismissed

The Federal Power Commission has dismissed the applications of South Georgia Natural Gas Company, of Atlanta, Georgia, South Central Alabama Natural Gas Company, Inc., of Birmingham, Alabama, and Georgia Natural Gas Company, of Albany, Georgia, all of which proposed to construct natural gas transmission systems in the South.

All three companies originally sought FPC orders directing Southern Natural Gas Company, of Birmingham, to supply the gas for the projects. South Georgia Natural Gas Company also sought an order directing Transcontinental Gas Pipe Line Corporation, of Houston, Texas, to supply gas as an alternative to Southern Natural.

Both South Georgia and South Central, however, amended their applications last April by withdrawing the requests for orders directing the interstate pipe line companies to establish connections with their systems. Both companies said that Southern Natural had indicated its intention to file in 1952 an application for FPC authorization to build additional facilities and that it would be "glad to give consideration to making provision" for their requirements.

In dismissing the South Georgia and South Central applications, the FPC said that they had been pending for more than a year and that there is no prospect of a firm gas supply in the immediate future.

South Georgia proposed to build about 527 miles of line to supply markets in Georgia and Florida. Estimated cost of the project was $10,500,000 if Southern Natural supplied the gas, and $12,080,000 if a connection was made with Transcontinental's system.

South Central Alabama wanted FPC authority to construct approximately 150 miles of line, estimated to cost $2,500,000.

The Georgia Natural project, estimated to cost $5,100,000, would have connected with Southern Natural's facilities near Phenix City, Alabama, and extended to Tallahassee, Florida, with laterals or branch line serving the principal towns in southwest Georgia adjacent to the proposed line.

United Withdraws Compressor Proposal

The Federal Power Commission has permitted United Gas Pipe Line Company, of Shreveport, Louisiana, to withdraw an application in which it proposed to add 21,280 hp of compressor facilities on its 30-in. natural gas transmission line, now under construction, from the Eugene Island area off the coast of Louisiana to the vicinity of Kosciusko, Mississippi.

The proposed facilities would have increased the capacity of the line by 101,000,000 cu ft of gas a day, which was to be sold to Southern Natural Gas Company. In its motion to withdraw the application, United said it now plans to supply Southern Natural from other sources.

Station and Loop Line Permit Sought

New York State Natural Gas Corporation, of New York City, has applied to the Federal Power Commission for authority to construct a 6600-hp compressor station at Dryden, New York, and 35.2 miles of 20-in. loop line extending north from the proposed station to the company's Therm City compressor station.

New York State Natural plans to install 3300 hp at the proposed new station in 1951; 1100 hp in 1952, and the remaining 2200 hp in 1953. The proposed pipe line would be constructed in 1953.

Overall capital cost of the compressor station is estimated at approximately $1,744,800, and estimated cost of the loop line is $1,875,700.

Atlantic Gulf Gas Must Redesign Project

The Federal Power Commission has denied the application of Atlantic Gulf Gas Company, of Shreveport, Louisiana, which was seeking authority to build natural gas transmission facilities to serve areas of Georgia, Florida, South Carolina, and Alabama.

The commission said that the company "has not shown that it is able and willing properly to do the acts and to perform the service proposed in its application . . . "

Atlantic's application was filed in April, 1947, and extensive hearings have been held since that time. The commission three times reopened the proceedings to permit Atlantic to prove its case, the last time by order of February 27, 1951. At that time the FPC said that Atlantic must introduce evidence of firm commitments for sufficient sales of its pipe line capacity to show convincingly that it is able to finance and construct the proposed facilities and that the project will be economically feasible.

At the reopened hearings, held May 14 and 15, Atlantic's witness said that the project, as presently designed, cannot be financed and could not be operated economically on the basis that Atlantic had under contract.

Atlantic was proposing to build approximately 1731 miles of pipe line extending from southeastern Louisiana through Mississippi, Alabama, Georgia, South Carolina and northern Florida. The most recent estimate of the total overall cost of the facilities was $98,700,000. The company proposed to serve 53 communities in Alabama, Georgia, South Carolina, and Florida, and 22 direct industrial customers.

The commission in a concurrent order denied an application by United Gas Pipe Line Company, also of Shreveport, in which it sought FPC authority to build facilities to sell and deliver natural gas to Atlantic.

Proposes Gas Expansion in Southeastern Missouri

Associated Natural Gas Company, of Tulsa, Oklahoma, has asked the Federal Power Commission for authority to expand its natural gas transmission system in southeastern Missouri to provide service to 14 towns in that area.

The company, which presently serves Sikeston and New Madrid, Missouri, is proposing to build approximately 88 miles of new line together with town border and distribution regulator stations and other necessary distribution facilities in the 14 towns. Estimated cost of the construction is $2,491,042, Associated Natural reported.

With the PIPE LINE CONTRACTORS

American Coating Supply Company (formerly Tulsa Pipe Coating Company), P. O. Box 3085, Whittier Station, Tulsa, Oklahoma, is coating 237 miles of 26-in. pipe for the Northern Natural Gas Company, which will be laid between Palmyra, Nebraska, and Skellytown, Texas. Buck Rogers is in charge of the work. Also for Northern Natural, 200 miles of 4-in. through 12-in. are being coated, which will be laid as a gathering system in the Hugoton, Kansas, area. K. C. Honn is supervising this job.

For Associated Gas Company, 147 miles of 1-in. through 8-in. pipe is being coated, the pipe to be used in a distribution system at Sikeston, Missouri. H. Duboise is superintendent.

Miscellaneous jobs include 50 miles of 2-in. through 24-in. at the Tulsa yard, Elvin Lair superintendent; 60 miles of 2-in. through 20-in. at the Oklahoma City yard, Lloyd Latham superintendent, and 40 miles of 2-in. through 16-in. at the Kansas City yard, Wayne Elgin superintendent.

Vaughn and Taylor Construction Company, Inc., Box 1351, Wichita Falls, Texas, is engaged in laying a 179-mile gathering system for Cities Service Gas Company in the Ulysses, Kansas, area. Pipe sizes range from 4-in. through 30 in. D. D. Vaughn is superintendent and C. E. Sayles office manager. The field office is at Ulysses.

Houston Contracting Company, 2707 Ferndale Place, Houston, Texas, has the following construction work under contract:

Approximately 158 miles of 30-in. gas line for Tennessee Gas Transmission Company. This work consists of four sections extending from the vicinity of Jones, Louisiana on the north to near Cypress, Texas, on the south.

One spread is laying approximately 46 miles from the vicinity of Galion, Louisiana, south to the vicinity of Iris, Louisiana. W. H. Hayes is superintendent; M. L. Thompson, assistant superintendent; J. C. Strickler and J. B. Stoddard, office. Headquarters are at Bastrop, Louisiana. Began laying pipe June 4.

One spread is laying approximately 42 miles from vicinity of Natchitoches, Louisiana, to the vicinity of Hemphill, Texas. E. C. Norris is superintendent; R. E. Thornton, assistant superintendent; R. J. Axsom, office manager. Headquarters are at Many, Louisiana. Approximately 30 miles were completed to the middle of June.

The third spread is laying two sections or a total of approximately 70 miles. The south 40 miles has been completed. Now laying 30 miles from the vicinity of Woodville, Texas, to vicinity of Jasper, Texas. F. A. Silar is superintendent; C. V. Oliver, assistant superintendent; L. F. Redfearn, office manager. Headquarters are at Woodville, Texas. Approximately 5 miles have been completed.

Approximately 42 miles of 6-in. and 8-in. take-up and yard reconditioning is being done for The Texas Pipe Line Company in the vicinity of Houston, Texas. H. L. Leake is superintendent; S. B. Harrison, assistant superintendent; H. C. MacWhinnie, office manager. Headquarters are at East Houston, Texas. Approximately 10 miles has been completed.

Western Pipe Line Constructors, Inc., Lockhart Building, Austin, Texas, is laying 121 miles of 30-in. and three river crossings for the Tennessee Gas Transmission Company. Working out of Dickson, Tennessee, one spread is laying 59 miles. Jack Hodges is superintendent and A. G. Goyne office manager. Another spread has its field office at Mt. Sterling, Kentucky, to lay 62 miles between Richmond and Salt Lick, Kentucky. W. B. Williams is supervising this crew and P. O. Rutledge is the office manager. The river crossings to be installed are of the Duck, Buffalo, and Tennessee.

Bishop and Lock, 503 Magnolia Building, Dallas, Texas, is waiting on pipe to begin work on the Platte Pipe Line Company job. This contractor will lay the 142-mile section from Marysville, Kansas, to Holdredge, Nebraska.

Brown and Root, Inc., P. O. Box 3, Houston, Texas, has a contract with United Gas Pipe Line Company covering various phases of engineering, construction, and other services on more than 1000 miles of pipe line, which will be laid in Texas, Louisiana, and Mississippi.

The contractor also is laying 88.7 miles of pipe for United, varying in size from 6⅝ in. to 16 in., from West Bay Field, Plaquemines Parish, Louisiana, to New Orleans. The field office is at Harvey. J. W. Kincy is superintendent; T. M. Strong, office manager.

Mahoney Contracting Company, 2300 North Grand River, Lansing, Michigan, in June was awarded a contract by Texas Eastern Transmission Corporation for 100 miles of 30-in. pipe line between the Kentucky River to the Ohio River in northeastern Kentucky. Previously a contract had been signed with Texas Eastern to lay 36 miles of 20-in. from Connelsville, Pennsylvania, to the Oakford storage area. This work is scheduled to begin as soon as the Trunkline job is completed, and Henry Mogg, who is in charge of one spread of the latter, will take over, making his headquarters at Greensburg, Pennsylvania.

The Trunkline Gas Company job is rapidly drawing to a close. This consisted of 100 miles of 26-in. from Flora to Joppa, Illinois. Two spreads are working. One is in charge of Henry Mogg, as mentioned, the other Barney Finnerty.

Other contracts are:

Dow Chemical Company, 70 miles of 4 through 22-in. branch lines from the Dow plant at Midland, Michigan. Ralph Bucher is superintendent.

Two water crossings in Venezuela for Shell Caribbean Petroleum Corporation. One is a 10-mile, 20-in. crossing of Lake Maracaibo, the other a 4-mile, 30-in. crossing of the Gulf of Coro. Angelo Tavernaro is in charge.

Harold Finnerty is general superintendent for Mahoney.

R. H. Fulton and Company, P. O. Box 1526, Lubbock, Texas, has signed a contract to lay 250 miles of 20-in. pipe line for Colorado Interstate Gas Company from Kit Carson, Colorado, to the Canadian River north of Amarillo, Texas. The starting date has not been announced.

The contractor has completed 45 miles of 16-in. on the west end of the Platte Pipe Line Company system and is now awaiting pipe to continue with that project. Altogether, approximately 570 miles of 16 and 20-in. will be laid for Platte, from Chatham station in Wyoming to Brule, Nebraska.

The 184-mile section of 26-in. for Trunkline Gas Company is progressing. This is between Senatobia, Mississippi, and Joppa, Illinois. Two spreads are being employed, one in charge of Ed Veach, the other Oscar Phillips. Clark Williams is general superintendent.

For Panhandle Eastern Pipe Line Company, 68 miles of 24 and 26-in. pipe will be laid in loops between Sneed, Texas, and Olpe, Kansas.

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Oklahoma Contracting Company, 6512 Hines Boulevard, Dallas, Texas, has completed laying pipe from the Albany River to the Massachusetts-New York state line southwest of Pittsfield, Massachusetts, on the New England system of Tennessee Gas Transmission Company and its subsidiary, Northeastern Gas Transmission Company. The overall contract calls for construction of 175 miles from the Hudson River just south of Albany to a point near Wilmington, Massachusetts. On Northeastern Gas' section 35 miles had been laid to June 18.

Central headquarters for the project are at Springfield, Massachusetts. Paul R. Halbert is in charge with Harry Prindle his assistant.

Spread headquarters are as follows:

Pittsfield, Massachusetts — H. A. "Red" Wylie, superintendent.

Westfield, Massachusetts—Aldress Kilgore, superintendent.

Sudberry, Massachusetts — L. B. Rea, superintendent.

G. G. Griffis, Inc., P. O. Box 418, Tulsa, Oklahoma, has been awarded the contract to lay approximately 210 miles of 26-in. loop lines for Northern Natural Gas Company in Texas, Oklahoma, Kansas, and Nebraska.

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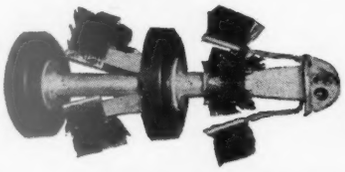
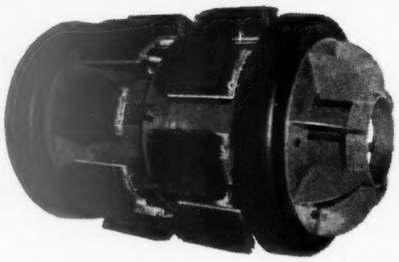
Use TYPE SCN-51 for 6" size.



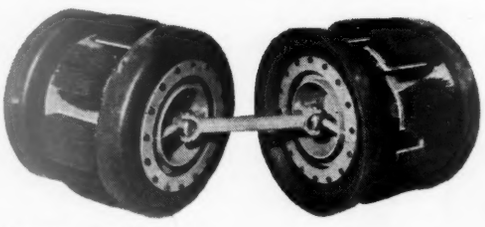
8" Size—TYPE WC-11—8" to 14" will traverse 6 foot radius field bends, full diameter side openings at 45°.

SPRINGS COMPENSATE for BRUSH WEAR.



20" Size—TYPE GP-2—16" to 30" 200 lb. SPRING forces the brushes against pipe wall—COMPENSATING for WEAR. Will traverse round opening gate or plug valves.

SPRINGS and BRUSHES are identical and interchangeable for all types and sizes of GP-PIGS.



24" Size—GP-3—18" to 30" sizes will pass 1½ R-30° bends. SPRINGS COMPENSATE for BRUSH WEAR ASSURING full section cleaning efficiency. GP-3 consists of two Type GP-1 Pigs. Each unit may be used as individual pig.

*Patents Pending

T. D. Williamson, Inc.

TULSA 9, OKLAHOMA

H. C. Price Company, Pipeline Division, Box 1111, Bartlesville, Oklahoma, has the general contract covering construction of approximately 156 miles of 24-in. high pressure natural gas pipeline for Tennessee Gas Transmission Company between Hamburg, New York, and the Onondaga-Madison county line, New York. Work was 35 per cent completed as of June 10. Spreads are as follows:

Auburn, New York, Box 657, telephone 24591: G. A. Reutzel, superintendent; W. E. Yount, office manager; and the following foremen: J. A. Hairston, right-of-way; L. J. Loncarich, ditch; J. C. Anderson, bending; H. C. Morrison, and K. N. Adkins, pipe; R. W. Orr, welding; S. J. Wood, coating; A. L. Bell, lower-in; T. E. Walker, clean-up; J. H. Ingram, Sr., chief mechanic.

Warsaw, New York, Box 214, telephone 618: R. K. Shivel, superintendent; W. R. Crego, office manager; J. D. White, right-of-way; W. H. Olrich, ditch; J. H. Latham, bending; Delbert Shivel, pipe; R. L. Ezell, welding; J. B. Northcutt, coating; C. W. Sisco, lower-in; Sam Price, clean-up; Cleo Robertson, road crossing; Tommie Stammer, chief mechanic.

General contract covering construction of approximately 193 miles of 30-in. high pressure natural gas pipe line for Texas Illinois Natural Gas Pipeline Company from the Trinity River northeastward to the Texas-Arkansas state line near Texarkana. Work was 35 per cent completed as of June 10. Spreads are as follows:

Carthage, Texas, general delivery, telephone, 1178: C. E. Shivel, superintendent; D. H. Johnston, office manager; C. F. Jones, right-of-way; R. H. Edwards, right-of-way; Ray Drewell, ditch; J. V. Huff, bending; E. D. Worley, pipe; John Stokes, welding; Henry Hill, coating; Bill Buchanan, lower-in; Paul McCormack, clean-up; Boyd Danner, chief mechanic.

Nacogdoches, Texas, Box 906, telephone 2198: C. R. Ice, superintendent; G. A. Harvey, office manager; W. O. Elliott, right-of-way; Jessie Cash, right-of-way; E. W. Whisenant, ditch; Forest Loinette, bending; W. T. Dickerson, pipe; L. O. Reutzel, welding; N. D. Adams, coating; J. C. Rich, lower-in; John E. Hamilton, clean-up; Cliff Birmingham, chief mechanic.

Williams Brothers-Davis Company, 6006 Jensen Drive, Houston, Texas, is constructing 165 miles of 30-in. pipe line for Texas Eastern Transmission Corporation, from Kosciusko, Mississippi, to Florence, Alabama. The field office is at the former point. Dick Hamilton, superintendent.

Rumsey Brothers Pipe Line Construction Company, M. and M. Building, Houston, is at work on 52 miles of 24 and 26-in. pipe line for Panhandle Eastern Pipe Line Company in Kansas. A start on its section of the Platte Pipe Line Company system, however, awaits receipt of pipe. Al Works will be in charge with Walter Hale the office manager.

H. B. Zachry Company, P. O. Box, San Antonio, Texas, has contracted to lay 72 miles of 30-in. pipe for Texas Eastern Transmission Company from Columbia, Tennessee, to the Cumberland River.

Bechtel Corporation, 220 Bush Street, San Francisco, California, is proceeding with its work on 409 miles of 30-in. in Arkansas and Missouri for Texas Illinois Natural Gas Pipe Line Company. The project office is at 409 East Markham Street, Little Rock, Arkansas. E. W. Davis is division manager, R. Hamilton assistant project manager, E. G. Hayes division office manager, and E. C. Elting project office manager.

Spread offices are as follows:

Newport, Arkansas, general delivery—B. C. McLean, office manager.

Bald Knob, Arkansas, general delivery—Virgil Cobb, superintendent, and C. A. Bingaman, office manager.

Hope, Arkansas, general delivery—V. L. Williams, superintendent, and Harry Sager, office manager.

Arkansas River crossing, Box 349, North Little Rock, Arkansas—George Wahlgren, superintendent.

Jackson, Missouri, general delivery—C. E. Barker, assistant project manager; Ray Abney, superintendent, and E. C. Gavagan, office manager.

Pocahontas, Arkansas, Box 122—J. F. Barbee, superintendent, and R. L. McElroy, office manager.

The contractor has just completed a line for General Petroleum Corporation from San Ardo to Estero Bay, California. This project consisted of 42 miles of 8-in. crude oil line and 42 miles of 4-in. for transporting cutter stock. The project office was at Watson with J. S. Connell general manager. The field office was at San Miguel with George Anderson manager.

Bechtel Constructors, Inc., 220 Bush Street, San Francisco, California, is laying 120 miles of 24-in. pipe for Tennessee Gas Transmission Company from Hamburg, New York, to the Hudson River. The work is in progress. The project office is at Richfield Springs, New York, PO Box 789. R. L. Bowman is general superintendent; W. H. Molander office manager.

Williams-Austin Company, Grant Building, Pittsburgh 19, Pennsylvania, on May 28 started two spreads going on New York State Natural Gas Corporation work. One spread is working out of Sauquoit, New York, laying 82.5 miles of 20-in. from Utica to Ithaca. This crew is in charge of Ralph Gaddy, with E. E. Mayes and L. A. Franks timekeepers. The second spread has its warehouse at Altamont and is laying 12 miles of 16-in. from Knox to Schenectady. Howard Bauer is superintendent and R. H. Condry timekeeper.

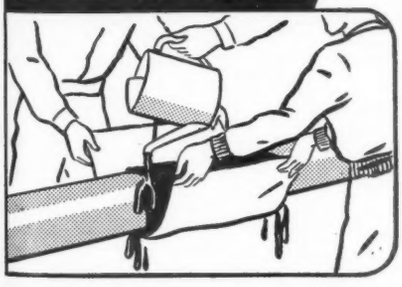
Two spreads also are at work on 40 miles of 10, 12, and 16-in. laterals for Niagara Mohawk Power Corporation. Leman Creech is supervising the laying of the 16-in. Utica line, with L. A. Franks timekeeper. The warehouse is at Sauquoit. Howard Bauer is in charge of the 12-in. Troy feeder line laid from Albany. R. H. Condry is timekeeper.

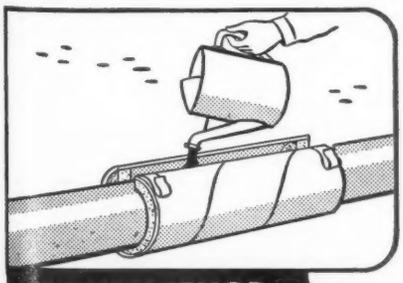
Ray L. Smith and Son, Inc., P. O. Box 391, El Dorado, Kansas, is just getting under way on 58 miles of 20-in. for Texas Illinois Natural Gas Pipe Line Company between Joliet, Illinois, and the Volo meter station. R. M. Jones is the spread superintendent, D. L. Marley office manager, Charles T. Lewis welding foreman, and Sonny Biller right-of-way foreman.

FIELD JOINTER
PAT. APPLIED FOR

Slip on-Pour full-Lower in

OLD METHOD





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"Field-Jointer" construction features heavy, rigid, paper mould equipped with felt inserts for each end, preventing waste, plus heavy adhesive tape fasteners. One-quarter inch spacing between pipe and mould gives positive assurance of protection. Slip on—Pour full—Lower in.

The "Field-Jointer" represents a new technique of coating field joints and skid-marks with the same material used on pipe at the coating machine. Slip-on "Field-Jointer" over joint, pour enamel, fasten, and you are ready to lower-in. The canvas sling method is slower, and does not provide assurance of adequate protection for pipe bottoms. Use of "Field-Jointer" provides following features for field use.

★ Eliminates waste of material
★ Eliminates clean-up operations
★ Operates simply requiring no skilled labor
★ Affords positive proof of pipe-bottom protection
★ Prices and additional information, plus arrangements for field demonstrations furnished on request.

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S. D. Day Co., 1973 W. Gray, Houston, Texas
Mel Maddox, P. O. Box 165, Little Rock, Arkansas
J. H. Longaker, 1204 Russ Bldg., San Francisco, Calif.

AMERICAN COATING SUPPLY COMPANY
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Box 3085—Whittier Station—Tulsa, Okla.

Associated Pipe Line Contractors, Inc., P. O. Box 2163, Houston, Texas, has contracted 100 miles of 20, 24, 26, and 30-in. to be laid for J. Ray McDermott and Company on the United Gas Pipe Line Company system. The pipe will be laid near New Orleans, Louisiana. L. H. Gray is superintending the work and James Luther and Ralph Herwig are in the office, which is at Franklin, Louisiana.

For the U. S. Corps of Engineers, 188 miles of 6⅝-in. pipe will be laid from Searsport to Limestone, Maine. The field office is at Bangor. Cecil Rogers is superintendent and A. B. Johnson office manager.

H. C. Price Company, Somastic Division, Bartlesville, Oklahoma, announces the following jobs:

Philadelphia Plant Operations:

Consolidated Edison Company — Application of Somastic coating and internal cleaning and coating to approximately 13,400 ft of 8⅝-in. OD pipe.

Okonite-Callender Cable Company, Inc.—Application of coating and internal cleaning and coating to 2250 ft of 8⅝. OD pipe; 33,000 ft of 6⅝-in. OD pipe; 25,720 ft of 5 9/16-in. OD pipe.

Phelps-Dodge Corporation—Application of coating and internal cleaning and coating to 30,360 ft of 6⅝-in. OD pipe; 55,500 ft of 5 9/16-in. OD pipe.

Philadelphia Electric Company — Application of Somastic coating to 500 ft of 20-in. OD pipe; 80,000 ft of 16-in. OD pipe; 3200 ft of 8⅝-in. OD pipe, and 3200 ft of 4½-in. OD pipe.

Philadelphia Gas Works Company —Application of coating to all pipe requirements from 1¼-in. to 30-in. for 1951.

At Staten Island, New York:

Transcontinental Gas Pipe Line Corporation—Application of Somastic coating to 20,000 ft of 24-in. OD pipe and application of 3-in. Hevicote to 20,000 ft of 24-in. OD pipe.

New Orleans Plant Operations: (At Morgan City, Louisiana):

Gulf Southern Contractors (for United Gas Pipe Line Company)— Application of Somastic coating to approximately 26.3 miles of 30-in. OD pipe; 23.8 miles of 26-in. OD pipe; 24.6 miles of 24-in. OD pipe; 15.6 miles of 20½-in. OD pipe; 21.1 miles of 20-in. OD pipe; 13.4 miles of 16-in. OD pipe.

At Harvey, Louisiana:

Gulf Southern Contractors (for United Gas Pipe Line Company)— Application of Somastic coating to approximately 64,944 ft of 14-in. OD pipe and application of 1-in. Hevicote to 64,944 ft of 14-in. OD pipe.

Mid-Valley Pipeline Company — Application of Somastic coating to 12,000 ft of ½-in. wall 20-in. OD pipe; 8000 ft of ¼-in. wall 20-in. OD pipe, and application of 1¾-in. Hevicote to 12,000 ft of 20-in. OD pipe.

O. R. Burden Construction Company, P. O. Box 5216, Tulsa, Oklahoma, has received enough pipe on the Platte Pipe Line Company job to begin work on the section into St. Louis, Missouri. The field office is at Moberly, Missouri. Altogether, Burden will lay 280 miles of the Platte system, the section from the Missouri River near St. Joseph, Missouri, to the Mississippi River near Wood River, Illinois.

A new job by this contractor is the take-up of 38 miles of 8-in. for The Texas Pipe Line Company from Glenn Pool to Henryetta, Oklahoma. Floyd Lewis is in charge, with headquarters at Okmulgee.

Conyes Construction Corporation, 2884 San Pablo Avenue, San Pablo, California, is constructing 75 miles of 30-in. pipe line for Panhandle Eastern Pipe Line Company from Tuscola to Zionsville, Indiana, and 65 miles of 30-in. from Zionsville to Fort Wayne, Indiana. Jimmy Allman is in charge of one spread and Morris Norwood the other.

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Lease Tank Service—West Texas Area: Williams Construction Company, Odessa, Texas

California Representative: Coast Contractors, Inc., 2627 Atlantic Ave., Long Beach 6, Cal.

▸ **Anderson Brothers Corporation,** 707 North Drennan Street, Houston, Texas, has recently contracted to lay 85 miles of 10-in. pipe line for the Triangle Pipe Line Company, from El Dorado to Arkansas City, Arkansas. The job is in progress with the field office at El Dorado. "Whitey" Myers is the superintendent.

Two spreads are at work on the 121 miles of 24-in. for Michigan Consolidated Gas Company between Big Rapids and Farmington, Michigan. The spread under supervision of Frank Whitlow is working out of Big Rapids. The one under Charlie Ingraham is making its headquarters at Ithaca.

Other jobs are as follows:

Panhandle Eastern Pipe Line Company, 90 miles of 26-in. from Toledo, Ohio, to Detroit, Michigan. Ray Bendure, superintendent.

Tennessee Gas Transmission Company, 90 miles of 30-in. from Drew to Holly Springs, Mississippi. Earl Saulsman, superintendent.

Tennessee Gas Transmission Company, 68 miles of 30-in. from Horse Cave to Campbellsville, Kentucky. E. E. McCoy, superintendent.

Trunkline Gas Company, 80 miles of 26-in. from Leland to Independence, Mississippi. Two spreads are working, one in charge of "Whitey" Gould, the other under the supervision of "Rusty" Killingsworth.

Trunkline Gas Company, 65 miles of 24-in. from Longville, Louisiana, to the San Jacinto River in Texas. L. J. Knox is superintendent. Headquarters are at Cleveland, Texas.

▸ **Dunn Brothers,** 801 Mercantile Securities Building, Dallas, Texas, (stringing contractors), have the following jobs under contract:

Texas Illinois Natural Gas Pipeline Company, Section 5, 91 miles of 30-in. from Urbana to Dotson, Texas, and Section 6, 99 miles from Dotson to the Texas-Arkansas state line.

El Paso Natural Gas Company, 415 miles of 24-in. in New Mexico and Arizona on the San Juan line.

El Paso Natural Gas Company, 419 miles of 30-in. in New Mexico, Texas, and Arizona.

Tennessee Gas Transmission Company, between 400 and 500 miles of 30-in. from Buffalo, New York, to the Massachusetts border.

Northeastern Gas Transmission Company, 65 miles of 16-in. in Connecticut and Massachusetts.

Tennessee Gas Transmission Company, 95 miles of 30-in. from Drew to Holly Springs, Mississippi.

Tennessee Gas Transmission Company, 60 miles of 30-in. from Colesburg to Dickson, Tennessee.

Tennessee Gas Transmission Company, 60 miles of 30-in. from Salt Lick to Richmond, Kentucky.

▸ **Percy Jones, Inc.,** P. O. Box 1083, Oklahoma City 1, Oklahoma, is hauling and stringing and/or picking up pipe on these jobs:

Gathering system in Hugoton, Kansas, gas field for Cities Service Gas Company, approximately 275 miles 4-in. through 30-in. pipe. Job just starting. Large part of pipe on long haul over-the-road haul.

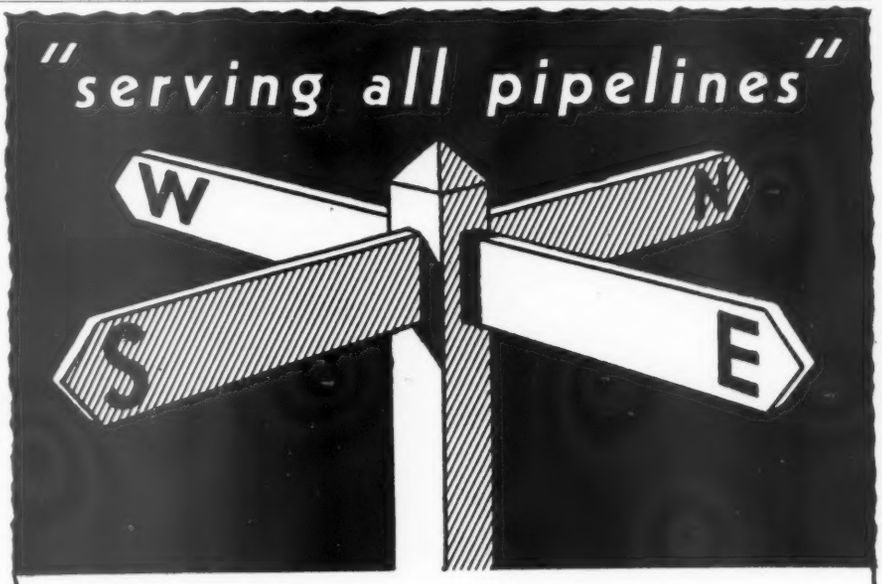
For Cities Service Gas Company, 30 miles 16-in. pipe from Wichita to Hesston, Kansas. Over half completed. Large part of pipe on long haul over-the-road haul.

Take-up 33 miles 8-in. pipe in Labette County, Kansas, for Cities Service Gas Company. Just starting.

Near Raymond and Great Bend, Kansas, for Pipeline Service Company, 34 miles of 4, 6, and 8-in. pipe. Large part of pipe on long haul over-the-road haul. Just starting.

All the above jobs are hauling and stringing jobs with the exception of the 33 miles of 8-in. which is a take-up job.

▸ **Somerville Construction Company,** Ada, Michigan, completed construction in June of 20 miles of 20-in. pipe line for Ohio Fuel Gas Company between New Albany and Homer, Ohio.



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Gulf Southern Contractors, 516½ Louisiana Avenue, Shreveport, Louisiana, has the contract to lay approximately 1000 miles of pipe line for United Gas Pipe Line Company, including a marine line into the Gulf of Mexico from the Louisiana coast. This is a contracting group composed of Texas-Louisiana Contractors, Oklahoma Contracting Company, J. Ray McDermott and Company, and Morrison-Knudsen Company, Inc.

Jayhawk Construction Company, Inc., P. O. Box 68, Great Bend, Kansas, has completed 35 miles (June 18) of the 126 miles of 6, 8, and 10-in. pipe it is laying for the Kansas-Nebraska Natural Gas Company. The line extends from Grand Island, Nebraska, to Albion, thence to Norfolk and Neligh, Nebraska.

Reese Brothers Construction Company, Hugoton, Kansas, will lay 181 miles of gathering lines for Northern Natural Gas Company in Texas County, Oklahoma, and Kearny, Finney, Haskell, Seward, and Morton counties, Kansas. The pipe will be of 4, 6, and 8-in. diam.

For Hugoton Production Company, 50 miles of 4-in. through 22-in. gathering lines are being laid in the Hugoton area.

Midwestern Constructors, Inc., 105 North Boulder, Tulsa, Oklahoma, announces the following progress report on its work for Texas Illinois Natural Gas Pipeline Company:

Schedule 11—100 miles of 30-in. from the Mississippi River near Chester, Illinois, to Effingham, Illinois, was 60 per cent completed the middle of June. Two spreads are working on this section. One has its headquarters at DuQuoin, Illinois, where Everett Hart is superintendent, the other at Carlyle, Illinois, where John Work is in charge.

Schedule 12—100 miles of 30-in. from Effingham to Sibley, Illinois. Field office is at Monticello, Illinois; Cliff Simmons is superintendent for the job.

Schedule 13 — 92 miles of 30-in. from Sibley to Joilet, Illinois, is 30 per cent completed. Denver Franklin is superintendent. Work is out of Morris, Illinois.

To construct the Mississippi River crossing near Wittenberg, Missouri, the crew has moved in and is ready to begin work. Three 20-in. lines will be laid. The field office is at Grand Tower, Illinois. Howard S. Lipp is coordinator, Clyde Peters, superintendent in charge of pipe, and Ivan Steele, office manager.

The central office for the Texas-Illinois work is at Decatur, Illinois. M. T. "Bill" Wilhite is general superintendent and A. T. Tolbert office manager.

Work of installing station additions and piping for Panhandle Eastern Pipe Line Company is progressing as follows: Tuscola, Illinois, 50 per cent completed. F. C. Snavely is superintendent and Morris D. Garey office manager. Zionsville, Indiana, 65 per cent completed. J. A. Bard is superintendent. Edgerton, Indiana, 60 per cent completed. Office is at Fort Wayne. Earl S. Powell is superintendent and H. H. Voss office manager.

Williams Brothers Company, National Bank of Tulsa Building, Tulsa, Oklahoma, recently began work on 78 miles of 20-in. for New York State Natural Gas Corporation, from Indiana, Pennsylvania, to Petersburg, on the Pennsylvania-Ohio state line. Clyde Gregory, superintendent; Walter Hammond, office manager. Field office is at Leechburg, Pennsylvania.

Four spreads are making good progress on the Plantation Pipe Line Company job from Baton Rouge, Louisiana, to Charlotte, North Carolina, 712 miles of 14 and 18-in. pipe line. George Allen is general superintendent, and the central project office is at Tuscaloosa, Alabama. The spread offices are located as follows:

Prentiss, Mississippi—O. R. Mitchell, superintendent, and R. J. Purdy, office manager.

Carrollton, Georgia—T. E. Davis, superintendent, and J. E. G. Jester, office manager.

Bessemer, Alabama—O. L. "Whitey" Martin, superintendent, and R. G. Conley, office manager.

Eutaw, Alabama—A. T. Maxwell, superintendent, and Joe Breedlove, office manager.

For the Venezuelan Atlantic Transmission Corporation, 195 miles of 10, 12, and 16-in. pipe are being laid from Las Mercedes to Caracas. For Shell Caribbean Petroleum Company, 160 miles of 30-in. are being laid from Palmerejo, near Maracaibo, to Punta Cardon, Venezuela. Both projects are under the supervision of Marvin Jones who is making his headquarters in Caracas.

Latex Construction Company of Georgia, Box 56, Northside Branch, Atlanta, Georgia, is doing pump station and terminal work for Plantation Pipe Line Company as a part of its expansion program. Station buildings are being enlarged to house additional units at Baton Rouge, Louisiana; Collins, Mississippi; Akron and Silver Run, Alabama; Bremen and Center, Georgia, and Spartanburg, South Carolina. Terminals are being enlarged at all main points between Baton Rouge and Charlotte, North Carolina.

Britton Contracting Company, 93 South Main Street, Washington, Pennsylvania, is working two spreads on the 116 miles of 16-in. pipe being laid for Northeastern Gas Transmission Company between Springfield, Massachusetts, and Greenwich, Connecticut. Herb Britton is general superintendent with headquarters at Springfield. One spread has its headquarters at Plainville, Connecticut. Johnny Waldron is spreadman. The other has its headquarters in Springfield. "Curley" Hahn, the superintendent.

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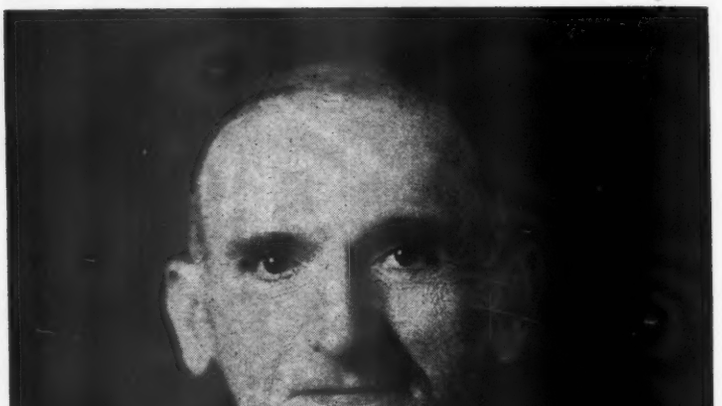
PETROLEUM PROFILE



LINDSAY BUFORD LITTLE

Petroleum Production Pioneer

WITHOUT pomp or ceremony, Lindsay Buford Little made his earthly debut in Gaffney, South Carolina, on May 16, 1881, and from that day to this has never known a moment's rest. Even when he relaxes he puts so much energy into it that he finds it far more relaxing to work. He can recite with uncanny accuracy the spud-in date, casing program, ultimate depth, completion date, and initial production of any well with which he was ever actively concerned. Indeed, he has often been called upon to establish from his remarkable memory the error or lack of error in the written records.

After attending grammar and high schools in Gaffney, and working at various jobs locally, Lin, as he was affectionately nicknamed, attached himself to the Southern Railroad as a fireman. About this time there came from Texas a friend, bringing the exciting news that oil men in the Spindletop were earning as much as $3 a day—a pretty fancy figure at that time. It was in fact a lure too enticing to be ignored, and on March 17, 1903, we find Lin breaking into the petroleum business as a rotary roughneck in the Evangeline field of Louisiana. Sixteen months later he was hired by Hayward Brothers Oil Corporation as a driller.

About three years after this, Hayward Brothers sold out to Gulf Oil Company, and shortly thereafter a Standard of California representative. J. R. McAllister, foraging around Louisiana in search of rotary rigs and rotary drillers for his company, signed up Lin Little and several others, including Cy Bell. The party landed in California in 1908, and Lin was immediately assigned to a well in King City, Monterey County.

When the eastern group, of which Lin Little was a member, first arrived in California with their new system of drilling, they were not too well received. It was generally argued that the rotary mud would seal off the oil sands and do irreparable damage to the wells. All sorts of other reasons were developed by the up-and-downers to discredit rotary drillers and their new fangled methods. But they had little effect. The swivel-necks were not to be diverted or dissuaded, and in time, as is now well known, they produced results. Lin points out that in all probability nothing so hastened the transition from cable tools to rotary in California as the fact that the cable tool drillers who were at first mortally afraid they would lose their jobs, were quickly educated in the new techniques and eventually themselves became rotary drillers.

The rotary outfits were then very small and light—the prime mover being commonly a single-cylinder 9 by 10 in. steam engine, with everything else in proportion. It took from 60 to 100 days to drill a 3000 ft well, what with blowouts, twist-offs, and all the other difficulties with which they were plagued. There was no electricity at the rigs, and for illumination at night they used primitive oil lamps. They sometimes even used natural gas for night lighting. And, to show their further disregard for safety, often had a forge right on the derrick floor. But improvement came fast and in a short time advances were being made in all phases of the drilling process.

In 1909 Lin was moved to Taft. Here he adopted George Keniston as his drilling partner, and together they began a series of drilling operations on Section 20. He was appointed rotary drilling foreman in 1911, and for about 2½ years he took care of his new responsibilities so capably that he was then elevated to the post of division superintendent in charge of the Midway division—an office he held for more than 6 years.

In 1919, Little was appointed general superintendent of Standard of Cal's entire San Joaquin Valley area, with headquarters in Bakersfield. Under his supervision the first exploratory well on the Hays property at Elk Hills was successfully completed. So also on February 12, 1920, was the now famous Tupman No. 1, which inside of a year had produced 1,692,724 bbl, thus establishing the west side of Elk Hills as the site of a substantial subsurface petroleum reservoir. He remained in the Valley for 7 more years and then was moved to Los Angeles headquarters as general superintendent of the Southern District. Here his jurisdiction extended over everything south of the Tehachapi, an assignment that until his retirement on December 1, 1942, kept him as fully occupied as any man has a right to be.

—Courtesy of Petroleum Production Pioneers, Inc.

NEWS

Supreme Court Upholds Col-Tex Refining's Claim

Col-Tex Refining Company has been backed up by the U. S. Supreme Court in its claim that it did not have to buy crude ratably from all fields on its 65-mile pipe line in four West Texas counties. The Texas Railroad Commission had ruled that a purchaser must buy oil ratably among fields as well as take ratably from wells within each field.

In Austin, Representative Joe Kilgore of McAllen has announced he would sponsor a bill in the present session of the legislature that would make it clear the Railroad Commission did have the power to require ratable taking of oil from all fields. If passed, this bill would nullify the effect of the Supreme Court's ruling.

Venezuelan Ambassador to U.S. Inspects Oil Facilities

Venezuela's Ambassador to the United States, Dr. Antonio Martin Araujo, arrived in Dallas recently, to tour oil and gas production, transportation, and distribution facilities of Texas and to inquire into oil and gas conservation practices.

Ambassador Araujo was accompanied to Dallas by other Venezuelan officials, including Dr. Jose Martorano Battisti, Minister Counsellor for Petroleum; Dr. M. A. Burelli Rivas, Embassy Counsellor; and Colonel Luis A. Calderon, Acting Military Attache.

The invitation to Dr. Aaujo was made by Jake L. Hamon, President of Mid-Continent Oil and Gas Association.

Gasoline Demand at Peak In 1950, The API REPORTS

The domestic demand for gasoline rose 8.26 per cent during 1950 to an all-time high of 40,613,400,000 gal, the American Petroleum Institute reported in its annual survey of gasoline consumption. The demand in 1950 was more than three billion gallons higher than the 37,515,278,000 gal consumed in 1949.

The new record consumption of motor fuel coincided with a sharp rise in automobile registrations of 10.7 per cent in 1950 to a total of 40,313,715, according to the Bureau of Public Roads. Truck registrations rose 7.2 per cent and bus registrations 7.1 per cent.

Gasoline production in the United States passed the billion barrel point for the first time in 1950, totaling 1,024,448,000 bbl or 43,026,816,000 gal and accounting for 43 per cent of all oil products refined last year.

Chapman Urges Use Of Synthetic Fuels

Synthetic fuels have been discussed pro and con in Washington recently, with the Interior Secretary Oscar Chapman championing the cause. Three oil state senators have argued that the petroleum industry can meet all requirements from known reserves. Chapman told the Senate Banking Committee that "it is time to put our oil shale and coal resources to work" in making gasoline oil and other liquid fuels.

From Washington comes the report that negotiations are progressing on a $275,000,000 project — privately financed —to build coal hydrogenation plants to make synthetic liquid fuels and chemicals. It was stated that an eastern syndicate has lined up several leading banks and insurance companies to provide the necessary capital, provided the government is willing to enter into long-term purchase contracts for the output of certain of the products.

The U. S. Bureau of Mines will refine more than 300,000 gal of high-octane synthetic gasoline for testing in U. S. Army trucks and other equipment. The gas will be obtained from oil derived from western Kentucky bituminous coal.

IOC Faces Extinction

The Interstate Oil Compact has only a short time in which to fight for extension of its existence. If by September 1 Congress has not granted authority to the IOC to continue its activity, this very worthy organization will expire.

It has been reported that one or two members of the congressional committee before whom the compact extending bills are now pending have made unfavorable references to the Compact.

The IOC works on a voluntary basis and the very lack of enforced rules and regulations may be baffling unless the wholehearted cooperation of members is understood and it is realized that the main purpose of the compact is practical conservation.

Research Book Out

Scientific research done by the Nation's engineering schools, and the part these schools play in building our scientific research capacity and training scientific manpower are subjects of a new book just off the press, called "Review of Current Research," the Office of Technical Services, U. S. Department of Commerce has announced. Copies of the book sell for $2.25, and may be obtained from the Office of Technical Services, U. S. Department of Commerce, Washington 25, D. C.

OIIC Makes Plans For Oil Progress Week

The Oil Industry Information Committee, concluding its quarterly meeting in Denver, Colorado, approved a report on the supply and demand of oil products in 1951 to be presented personally by local oil men to the editors of the nation. The report represents findings from all segments of the industry. Basic plans were reviewed for the nationwide observance of Oil Progress Week, October 14-20, when local oil men will again report to their own communities through speeches, radio programs, exhibits and special events.

Supporting the efforts of local committees will be billboards, service station window displays, exhibits, tie-in, newspaper and radio advertising.

Oil Industry Will Have Its Own NPC Chairman

The oil industry will once more have one of its own executives as chairman of the National Petroleum Council. This was a victory for the oil industry, which has been battling with Attorney General J. Howard McGrath who has been insisting for several months that the chairman should be a paid government employee. With the aid of Secretary of Interior Oscar Chapman, however, Walter S. Hallnan, president of the Plymouth Oil Company is serving as chairman of the council on a temporary extension of his 1950 term, as it was decided not to change chairmen until this dispute with the Justice Department was settled.

Cities Service Awarded

Four divisions of Cities Service Oil Company (Delaware), took industry-wide awards, including one first and one second place, in the National Safety Council's contest for the petroleum industry for 1950. The exploration department of the geological division was awarded a first-place plaque. The natural gasoline and chemical division won a second place certificate for completing a year's operations without a reportable accident.

Standard Educators' Host

Representative educators from at least a dozen major universities and colleges in the West have been invited to spend two weeks "behind the scenes" with Standard Oil Company of California early next fall, to get a first-hand look at the oil business. The study is scheduled to begin September 10. It is designed to complement Standard's program of scholarships and fellowships, and its program that provides educational aids to schools.

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Crown Royalties Up On Alberta Oil

Crown royalties have been increased 12.5 per cent at production of about 50 bbl a day, on Alberta oil, according to N. E. Tanner, minister of mines and minerals. They will be scaled down sharply from 50 to about 5 per cent at 25 bbl per day and up from 50 to the maximum of 162/3 per cent at a rate between 125 to 150 bbl a day.

The Western Canada Petroleum Association had protested the increase, on the grounds that out of $84,000,000 worth of oil produced in Alberta in 1950 the government had reaped, at no risk, an income of nearly $50,000,000 from royalties, lease, and reservation fees, and sale of Crown lands. The oil industry spent $150,000,000 in exploration netting only about half that sum from sale of oil after royalty payments.

Imperial Ups Oil Price

Imperial Oil Company has announced price increases of 1 to 3 cents a barrel for crude oil from Alberta oil fields. The changes became effective on deliveries dating from June 1. Oil from the Golden Spike field received the biggest boost, with an increase of 3 cents per barrel, bringing the price to $2.62. In Redwater crude oil will be increased 2 cents, making the price $2.46 a barrel.

Penn Grade Oil Men Discuss Steel Problems

A lack of steel for drilling and development and crude oil prices frozen at an "inadequate level" form major problems facing the Pennsylvania oil industry, speakers told a meeting of the Pennsylvania Grade Crude Oil Association in Pittsburgh recently.

C. E. Streeter of Bradford, Pennsylvania, president, opened the organization's 28th annual meeting in Hotel William Penn. He contrasted boosts of 35 per cent in textile prices and 22 per cent in farm prices with an advance of 6 per cent in Pennsylvania crude since outbreak of the Korean war.

George J. Hanks of Bradford, president of South Penn Oil Company and association vice president, warned, "Without steel being available to our industry in required amounts, the supply of Penn Grade crude cannot be maintained." He said steel available now and expected in the next quarter will be exhausted in view of the current drilling and developing rate.

Louisiana Oil Anniversary

Louisiana is celebrating its Golden Oil Jubilee on September 21, 22, 23. September 21 is the anniversary of the discovery of oil in Louisiana, which took place in the Jennings field on September 21, 1901. Celebrations will be held in the city of Jennings.

The group above is discussing the $14,000,000 natural gas production loan recently made to the Delhi Oil Corporation. They are: Seated, Fred F. Florence, president, Republic National Bank, and P. T. Bee, executive vice praesident, Delhi Oil Corporation, Dallas, Texas; I. D. Burstein, attorney for New York Life Insurance Company, New York. Standing: Byron Mitchell, vice president, Society for Savings, Cleveland, Ohio; Rushton L. Ardrey, vice president, Republic National Bank, and Eugene M. Locke of Locke, Locke and Purnell.

Anti-trust Charges Dropped Against Oil Companies

Latest development in the government's "Mother Hubbard" anti-trust suit against the American Petroleum Institute and 225 oil companies, which was dropped recently, proved that the case had been legally dead since October 31, 1948, Milburn Petty, The Petroleum Engineer Washington correspondent, reported. When dismissal papers in the case were filed, a docket book entry showed that the case had been dropped under Rule 13, which automatically dismisses a suit that has been inactive for 6 months.

Although the rule requires that all parties concerned in the case be notified, it also states that should the parties not be notified, the case is still dismissed.

The mass suit had charged the defendants with monopolizing the oil industry—from crude oil products through retail sale of finished products. Attorney General J. Howard McGrath announced dismissal of the "Mother Hubbard Case" because the suit was too complicated. Same objectives will be pursued through separate actions involving fewer defendants and more limited issues, McGrath stated.

Oil Concerns Found Guilty Of Monopolistic Practices

Five Standard oil companies and Atlas Supply have been found guilty of monopolistic practices in tire, battery, and auto accessory sales. The government charged that the companies used their vast purchasing power to force manufacturers to give them lower prices or discounts and rebates denied other competitors.

The decision, made by Examiner Everett F. Haycraft, was filed with the Federal Trade Commission and will become FTC's decision automatically in 30 days unless there is an appeal or the FTC initiates a review.

Haycraft's finding of violations of the Federal Trade Commission act and the Clayton antitrust act were directed against Standard of New Jersey, Kentucky, California, Ohio, and Indiana, and Atlas Supply of Newark.

Phillips Buys Penn-O-Tex Oil

Phillips Petroleum Company has purchased all of the capital stock of Penn-O-Tex Oil Corporation of Minneapolis from Mr. and Mrs. F. M. Starling, long time residents of that city. Facilities acquired by Phillips include a water terminal on the Mississippi River, a four truck loading dock, a 16-spot tank car loading rack, six storage tanks with a capacity of 351,000 bbl, and a rail terminal in Minneapolis.

IPAA Names Committee To Study Oil Supply

J. Ed Warren of Midland, president of the Independent Petroleum Association of America, has announced appointment of a committee to study and advise the association on the supply and availability of petroleum in the western hemisphere. Appointment of the committee was authorized by IPAA directors at their recent mid-year meeting in Denver, Colorado. Its study will include:

1. Availability of oil in the Western Hemisphere.
2. Study of sources of supply including means of making them available for future use, and securing and embracing new areas of development, synthetic processes, conservation, and technological advancement.
3. Means of building excess productive availability for future industry exploration for emergency defense requirements.
4. Recommending legal means of correlating various sources of supply to encourage progressive growth without injury to individual areas.

Rationing in U. S. Foreseen If Middle East Oil Lost

Loss of Middle East oil to enemies of the United States might require rationing of oil products here on a scale far more severe than ever before, Charles L. Harding of New York, director in charge of Middle East oil affairs, Socony - Vacuum Oil Company, reminded Pennsylvania Grade Crude Oil Association at Pittsburgh recently. "We have little excess producibility on which to draw if we are called on to supply western Europe with oil now coming from Iran," he warned them.

Loss of Middle East oil, he said, would confront this nation with the choice of rationing its own people or turning its back on Europe after having spent billions to promote economic recovery there.

U. S. Oil Imports Down

Imports of foreign oil and products totaled 808,400 bbl for the week ended June 9, and 838,700 for the four weeks ended that date. This compared with 908,300 bbl imported during the four weeks ended May 12, the American Petroleum Institute has reported.

The following table includes figures on imports of crude and residual oil:

Four Weeks Ended	Crude Oil	Residual Oil	Other Products	Total
June 9	547,900	259,200	21,600	838,700
Weeks Ended				
May 19	618,300	306,600	29,700	954,600
May 26	488,300	260,800	35,800	784,900
June 2	556,700	230,100	20,100	806,900
June 9	528,200	239,400	22,800	808,400

A. A. Stambaugh, chairman of the board, Standard Oil Company of Ohio; R. S. Blazer, president, Ashland Oil and Refining Company; W. W. Vandeveer, director, Ashland; M. A. Baur, district manager, Socony-Vacuum Oil Company, at the testimonial dinner for Blazer.

Blazer Gets Recognition

Seventy-five members of the petroleum club of the Cleveland, Ohio Chamber of Commerce attended a testimonial dinner for Rexford S. Blazar at the Cleveland Hotel recently. Blazer is a past president and director of the Cleveland Petroleum Club and an active member for many years. He was recently elected president of Ashland Oil and Refining Company.

Blazer is also president of two Ashland affiliates: Allied Oil Company of Cleveland and Frontier Oil Refining Corporation of Buffalo. He is a director of the National Petroleum Association and the Western Petroleum Refiners' Association. He has been associated with Allied Oil Company and active in oil industry affairs for nearly 25 years.

Fuel Oil Prices Boosted

Fuel oil prices have been raised along the Eastern seaboard by the major oil companies, on the authority of the Office of Price Stabilization in a move to increase coal consumption in the face of a possible fuel shortage this winter. Price increases ranged between 17 cents and 31 cents a barrel, with prices raised 30 cents at New York, Philadelphia, and Baltimore, and 31 cents at Boston. Most companies boosted prices on all grades of heavy fuel oil.

French Engineers in U. S.

The French petroleum industry has sent 11 young engineers to this country on a 9-month study, which is expected to make an important contribution to the French output of petroleum products. The engineers, who have completed the most advanced academic training available in France, also have some experience and a good knowledge of the different aspects of the vital oil industry in France.

Their study of the U. S. oil industry is sponsored under the technical assistance program of the Economic Cooperation Administration. It will consist for the most part of in-plant training with various American oil companies, under the direction of the University of Texas.

The young engineers' studies and training will be planned to fit the French oil industry's needs in the four fields of prospecting, production, refining and utilization.

Indonesia May Request Increased Oil Royalty

A report from Indonesia states that rumors of nationalization of Indonesia's huge oil fields are prevalent. Teuku Hassan, former governor of the Province of North Sumatra, is sponsor of new legislation, which demands that the big oil companies share substantially larger shares of their profits with the government.

Indonesia, chief producer of petroleum in the Far East, produces annually 6,000,000 tons of oil products. Most of the country's oil production is handled by two foreign companies, the BPM of the Royal Dutch Shell group and Standard Vacuum.

PERSONALS

Herbert E. Randlett, Jr., has been named technical representative in the New York office of Shell Development Company. He replaces **Harry K. Sutherland** who has left for California where he will be assistant director of Shell Oil Company's agricultural laboratory at Modesto. Randlett, who joined Shell in 1939 as a chemist at Martinez, California, was transferred to San Francisco as an engineer in 1943. In 1950 he was named administrative assistant to the director of research at Shell Development's Emeryville laboratories, a position he held until his present appointment.

Herbert A. Gidney has retired from his official positions with Gulf Oil Corporation, the board of directors has announced. He has been associated with Gulf for more than 31 years as a member of the board, executive vice president, a member of the executive committee, finance committee, and numerous other important management and employee benefits committees. He joined Gulf in January, 1920, becoming chief accounting officer in the same year. He became comptroller in 1925; vice president in 1935. His election as a director of the company and its principal domestic subsidiaries followed in 1941, and was elected executive vice president in 1948.

E. C. Petty, professor of economics at the University of Oklahoma, has accepted a scholarship granted by the Foundation of Economic Research, to study world movements of crude petroleum and its products. He will study particularly crude oil movements in the Caribbean basin and the oil fields surrounding the Gulf of Mexico. Before joining the University in 1927, Petty was economist for Marland Oil of Ponca City, Oklahoma.

Erasmo T. Guerrero, who last year received a $2000 fellowship from Magnolia Petroleum Company for graduate study in petroleum engineering at Texas A. and M. College, has been named to receive the award again this year and complete his study. Under the Magnolia fellowship, he is working for his doctor's degree, studying the effect of surface and interfacial forces on the recovery of oil from petroleum reservoirs. Magnolia Petroleum Company is sponsoring the fellowship to encourage petroleum engineering studies of a fundamental nature on the doctorate level. The $2000 covers a 10-month period of study.

Carl E. Cummings, superintendent of The Texas Company Beacon Laboratories, has been named commanding officer of The Quartermaster General's Petroleum Augmentation Unit. The unit, activated in November 1950, is an integral part of the Organized Reserve Corps program. It was established to provide a nucleus for rapid expansion of the Army petroleum organization in the event of emergency.

Including Col. Cummings, the unit consists of 17 Army Reserve Officers primarily from the petroleum industry. These are: Lt. Col. F. P. Robinson and Capt. R. H. McGuiney of Ethyl Corporation; Lt. Col. D. D. Mossman of Hunter College; Lt. Cols. J. A. Dimock, J. L. Bauer, Jr., and R. J. Finnegan, and Major W. B. Endendyk of Esso Standard Oil Company; Lt. Colonel H. J. Holcomb and Captain J. C. Clarke of Socony-Vacuum Oil Company; Majors Thornton Beall, and C. H. Phillips, and Captain J. C. Pearson of Shell Oil Company; Majors J. B. Stobaeus, Jr., Enjay Company, Inc., and C. H. Peckworth of Platt's Oilgram; Captain E. E. Hunter of The Texas Company; and 1st Lt. A. E. Bruggemann of Mercury Oil and Shipping Company.

C. E. Streeter, Bradford, Pennsylvania, oil producer, was reelected president of the Pennsylvania Grade Crude Oil Association for a third one-year term, at the 28th annual meeting recently. The association's board of directors, meeting in Hotel William Penn, named as a new officer **C. A. Chipman,** oil producer of Bolivar, New York, second vice president, **George J. Hanks** of Bradford, president of South Penn Oil Company, moved up from second to first vice president.

Four new directors have been elected: They are **Jack Cashell**, Preston Oil Company, Columbus, Ohio; **J. P. Healy,** president of Bradford District Oil Producers Association, Bradford, Pennsylvania; **G. Allan Reid,** South Penn Natural Gas Company, Parkersburg, West Virginia; and **Knight Thornton,** Thornton Oil Company, Wellsville, New York.

W. H. Kraft has been elected director of Honolulu Oil Corporation. Kraft and **F. M. Cole** were elected vice presidents. Kraft was employed by Honolulu Oil Corporation in 1925, and has been in charge of all gas and gasoline operations of the company throughout California and the Mid-Continent for over 10 years. Cole was employed by the company in 1937 and has been assistant to the executive vice president since 1947.

Dr. Robert E. Wilson

Dr. Robert E. Wilson, of Chicago, chairman of Standard Oil Company presented the third Cadman Memorial Lecture at the Royal Institution in London, England, recently. He addressed the Institute of Petroleum on "Competitive and Cooperative Research in the American Petroleum Industry." Second American to be so honored, he received the Cadman Memorial Medal at the proceedings. The Cadman Medal is awarded by the Institute of Petroleum in memory of Lord Cadman, chairman of the Anglo-Iranian Oil Company and the Iraq Petroleum Company.

B. Bynum Turner has been elected a vice president of Ethyl Corporation. He will direct a new department, which has been established to unify all of the company's activities in research, engineering, product development, and new construction.

Turner, who has been general manager of the manufacturing department since December, 1949, will be succeeded by **Clinton W. Bond. Roy N. Clothier** has been named plant manager to fill Bond's post at Baton Rouge, Louisiana, and **Wallace F. Armstrong** has been appointed plant manager of the Houston, Texas, plants now being constructed.

George V. Holton, chairman of the board of Socony-Vacuum Oil Company, Inc., has been re-elected president of the Commerce and Industry Association of New York, Inc. Holton, who is entering his second one-year term as president of the association, became associated with Socony-Vacuum as associate general counsel in 1931, when the Vacuum Oil Company, of which he then was a director and general counsel, merged with the Standard Oil Company of New York to become Socony-Vacuum Corporation (now Socony-Vacuum Oil Company, Inc.)

▸ **E. F. Kindsvater,** Phillips Petroleum Company has been transferred to the Washington office of the company, where he will work primarily on the procurement and allocation of materials. Other changes in the company's engineering and research and development departments are:

George R. Benz has been named head of the engineering department, after 26 years in that department. He replaces **A. H. Riney,** who has resigned as vice president, after being head of the engineering department for 30 years. Riney will be available for consultation by the manager of the engineering department and on specific assignment of the chairman or the president. Benz will be replaced by **C. K. Buell,** presently assistant manager of the chemical engineering division of the research and development department. **R. C. Cole** will replace Buell as assistant manager, and **R. E. Weis** succeeds Cole as superintendent of Philtex experiment station.

▸ **Gentry Lee,** of Tulsa, Oklahoma, has been appointed general counsel of Cities Service Oil Company (Delaware). **Frank H. Bacon** of the Bartlesville legal staff has been appointed general attorney.

Lee is a partner in the law firm of Conner, Winters, Lee, and Randolph and has been engaged in the general practice of law in Tulsa for several years. He is general counsel and secretary of Bareco Oil Company and has been a director of that company since 1939. He is also serving on the legal committee of Western Petroleum Refiners Association. He attended Southern Methodist University in Dallas and received his law degree from the University of Oklahoma in 1924. Lee was president of the Tulsa Bar Association in 1950.

▸ **Allen Howard,** manager of Shell Oil Company's auditing department was elected president of the New York chapter of the Institute of Internal Auditors, it was announced recently.

▸ **W. S. S. Rodgers** has been elected chairman of the Board of the Arabian American Oil Company (ARAMCO). He succeeded **H. D. Collier,** who had served as chairman since 1940. Collier remained as a director of the company.

▸ **William D. Bickham,** secretary of Socony-Vacuum Oil Company, Inc., has been elected a vice president of the American Society of Corporate secretaries. He was also elected to the board and executive committee of the society.

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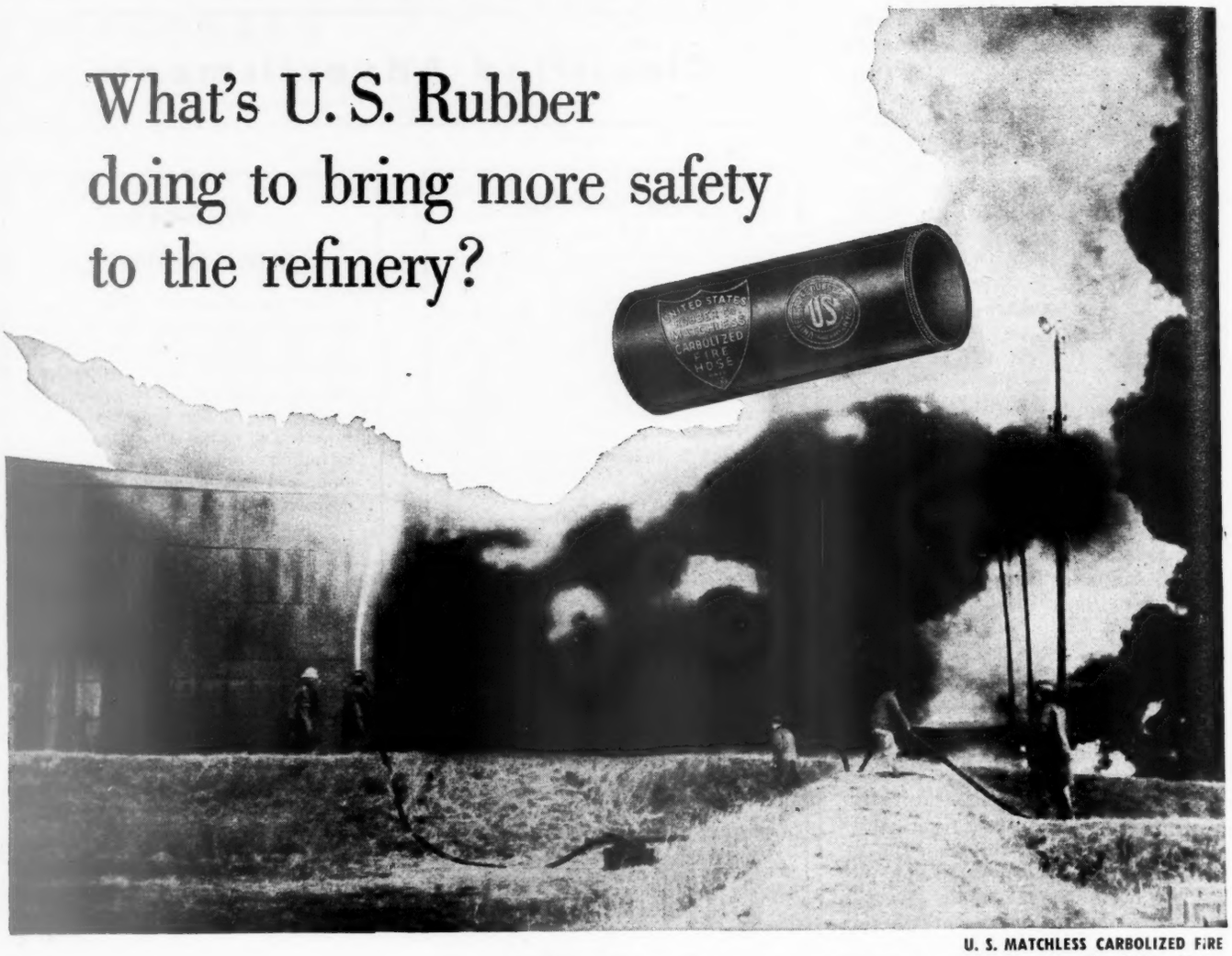

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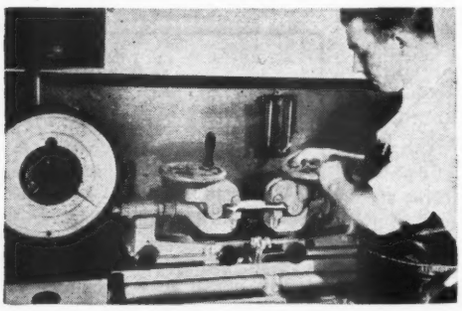

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BIBLIOGRAPHY—Classified list of important papers for 1949 - 1950

Austin, M. E., Water Treatment for Water Flooding in Michigan, Secondary Recovery Producers Monthly 15, 5, 18, March, 1951

Azorlosa, J. L., (Hurd, C. D.), Deuterium Tracers in the Pyrolysis of Butane and Propylene, J. Am. Chem. Soc. 73, 33-7, Jan., 1951

B

Bachman, W. S., Fatigue Testing and Development of Drill Pipe-To-Tool Joint Connections, ASME, Annual Petr. Mechan. Engr. Conference, Roosevelt Hotel, New Orleans, La., Sept. 24-28, 1950.

Baechler, R. H., (Richards, C. A.), Deterioration of Wood in Cooling Towers, ASME. Spring Meeting and Region IV Student Branch Conference, Atlanta Biltmore Hotel, Atlanta, Ga., April 2-5, 1951

Baerg, A., (Klassen, J. and Gishler, P. E.), Heat Transfer in a Fluidized Solids Bed, Can. J. Research 28, (F), 287-307, Aug., 1950.

Bailey, J. R., (Barton, A. D., Lochte, H. L., and Roberts, S. M.), The Nitrogen Compounds in Petroleum Distillates. XXVII. Isolation and Identification of 2, 3-Dimethyl-6-isopropyl-pyridine from California Petroleum. J. Am. Chem. Soc. 72, 3007-9, July, 1950.

Baker, D. R., Recent Studies in Cooling Tower Wood Deterioration, Midwest Power Conference, Sherman Hotel, Chicago, Ill., April 4-6, 1951

Baker, H. Dean, (Ryder, E. A.), The Precise Measurement of Temperature as an Aid to the Study of Heat Transfer, ASME, Annual Meeting, Hotel Statler, New York, N. Y., Nov. 26-Dec. 1, 1950.

Baker, Hines H., Tax Policy and Petroleum Supplies, API, Annual Meeting, Div. of Prod., Biltmore Hotel, Los Angeles, Calif., Nov. 15, 1950.

Baker, R. E., Testing Gasoline Plant Rectifier Performance, CNGA, Fall Meeting, Ambassador Hotel, Los Angeles, Calif., Nov. 9-10, 1950

Baker, W. E., Use of Aluminum in Petroleum Refinery Equipment, API, Mid-Year Meeting, Div. of Refining, Mayo Hotel, Tulsa, Okla., May 1, 1951

Baldeschwieler, E. L., (Clark, Ralph O.; Gambrill, C. M.; Headington, C. E.; Levin, Harry, Powers, J. M.; and Rather, J. B., Jr.), The Quenched Electrode Procedure in Spectrographic Analysis, API, Mid-Year Meeting, Div. of Refining, Mayo Hotel, Tulsa, Okla., April 30-May 3, 1951

Ball, J. S., (Stanfield, K. E.; Thorne, H. M.; Murphy, W. I. R.; and Horne, J. W.), Characteristics and Utilization of Oil Shale Oil, Ind. and Engr. Chem. 43, 1, 20-27, Jan., 1951

Bandaruk, W., (Simard, R. G.; Hasegawa, I.; and Headington, C. E.), Infrared Spectrophotometric Determination of Oils and Phenols in Water, API, Mid-Year Meeting, Div. of Refining, Mayo Hotel, Tulsa, Okla., April 30–May 3, 1951

Barber, R. C., Porosity-Permeability Check by Electric Log, World Oil 131, 3, 165-175, Aug., 1950

Barger, H. S., Water Flooding in the Illinois Basin Area Yesterday, Today and Tomorrow, AIME, Annual Meeting, Petr. Br., Statler Hotel, St. Louis, Mo., Feb. 17-22, 1951

Barkle, J. E., (Schaukle, D. F.), Electronic Excitation Midwest Power Conference, Sherman Hotel, Chicago, Ill., April 4-6, 1951

Barnard, D. P., The Role of Fuel in Engine Development, SAE, Annual Meeting, Hotel Book-Cadillac, Detroit, Mich., Jan. 8-12, 1951

Barnet, W. I., (Sohns, H. W.; Mitchell, L. E.; Cox, R. J.; and Murphy, W. I. R.), Heat Requirements for Retorting Oil Shale, ACS, 117th Meeting, Div. of Gas and Fuel Chem., Houston, Tex., March 26-30, 1950

Barron, Saul, Low Temperature Lubrication of Aircraft Engines, SAE, Annual Meeting, Hotel Book-Cadillac, Detroit, Mich., Jan. 8-12, 1951

Barrow, G. M., (McClellan, A. L.), The Thermodynamic Properties of Naphthalene, J. Am. Chem. Soc. 73, 573-5, Feb., 1951

Bartholomew, Richard N., (Katz, Donald L.), Heat Transfer to Fixed Fluidized Beds, AIChE, Regional Meeting, Kansas City, Mo., May 13-16, 1951

Bartley, J. H., (Haigh, Berte R.), Prospective Pennsylvanian Reef and Non-Reef — Areas of West Texas, World Oil 131, 4, 73-80, Sept., 1950

Barton, A. D., (Lochte, H. L.; Roberts S. M.; and Bailey, J. R.), The Nitrogen Compounds in Petroleum Distillates. XXVII. Isolation and Identification of 2,3-Dimethyl-6-isopropyl-pyridine from California Petroleum, J. Am. Chem. Soc. 72, 3007-9, July, 1950

Bartram, John G., Why Do Many Geologists and Engineers Disagree on Well Spacing, Oil and Gas J. 49, 12, 216-219, 325-330, July 27, 1950

Bass, Harry W., Free Enterprise, NGAA, Annual Convention, Mayo Hotel, Tulsa, Okla., April 25-27, 1951

Batchelder, H. R., (Newman, L. L. and Schmidt, L. D.), Manufacture of Fuel and Synthesis Gas in the United States, Fourth World Power Conference, London, England, July 10-15, 1950

Bates, Clinton, (Martin, J. R.), Unusual Control Valve Practices in a Petroleum Refinery, Petr. Refiner 30, 1, 111-118, Jan., 1951

Bates, H. G. C., (Evans, M. G. and Uri, N.), Oxidation by Photochemical Electron Transfer Excitation, Nature 166, 869, Nov. 18, 1950

Bates, W. F., The Use of Tubing as Drill Pipe, API, Annual Spring Meeting, Pacific Coast Dist., Div. of Prod., Biltmore Hotel, Los Angeles, Calif., May 11-12, 1950

Batuyev, M. E., (Plate, A. F.; Shafran, P. N.; and Lomonosov, M. V.), Hydrocarbons of the Cyclopentane Series with a Double Bond in the Side Chain. II. Vinylcyclopentane, J. Gen. Chem. (USSR) 20, 505-11, March, 1950

Bauer, Robert D., (Gilmore, Forrest E.), Modern Trends in Gas Plants for Catalytic Cracking Units, AIChE, Regional Meeting, Kansas City, Mo., May 13-16, 1951

Bayless, Fred, Securing Employee Cooperation in Safety, Drilling Industry Safety Clinic, Annual Meeting, Dallas, Tex., May 3, 1951

Beach, Floyd K., Alberta Oil Development in 1950, World Petr. 22, 4, 52-53, April, 1951

Beck, C. A., Near Ultraviolet Absorption Spectrum of Hydroquinone, Resorcinol, and Catechol, J. Chem, Phys. 18, 1135-42, Sept., 1950

Beenfeldt, E. L., (Diehlman, George), Preventing Corrosion With Protective Paint Coatings, Corrosion 7, 3, 88-92, March, 1951

Beeson, Carrol M., (Tchillingarian, George), Iranian Gums as Treating Agents for Drilling Fluids, AIMME, Petr. Br., Los Angeles, Calif., Oct. 12-13, 1950

Beeson, Carrol M., (Wright, Charles C.), Mud Loss to Formation Pores, AIMME, Petr. Br., Los Angeles, Calif., Oct. 12-13, 1950

Beeson, H. H., Financial Significance of Fractional Analysis, NGAA, Texas Hotel, Fort Worth, Tex., March 15-16, 1951

Beeson, H. H., Fractional Analysis, Oil and Gas J. 49, 50, 172, 222-223, April 19, 1951

Belcher, R., (Ingram, G.), The Absorption of Nitrogen Oxides in the Micro Determination of Carbon and Hydrogen, Anal. Chim Acta 4, 401-10, Aug., 1950

Bell, Alfred H., Oil Possibilities of Niagaran Reefs in Illinois, World Oil 132, 1, 74, 77-78, Jan., 1951

Bell, A. H., (Kline, Virginia), Oil and Gas Developments in Illinois During 1949, J. Petr. Technol. 2, 167-208, Oct., 1950

Bell, John S., (Evans, Willy W.), Oil and Gas Developments in East and East Central Texas During 1949, Petr. Technol. 2, 8, 118-130, Aug., 1950

Bell, John S., (Shepherd, J. M.), Pressure Behavior in the Woodbine Sand, AIMME, Petr. Br., New Orleans, La., Oct. 4-6, 1950

Benedict, Manson, (Boas, Arnold), Separation of Gas Mixtures by Mass Diffusion, Part II, Chem. Engr. Prog. 47, 3, 111-122, March, 1951

Benner, F. C., (DiNardo, A.), Remote Condenser Falling-Film High Vacuum Still, ACS, 117th Meeting, Div. of Industrial and Engineering Chemistry, Houston, Tex., March 26-30, 1950

Bennett, J. S., Spreader Stokers for Large Boilers, Midwest Power Conference, Sherman Hotel, Chicago, Ill., April 4-6, 1951

Benson, H. E., (Crowell, J. H.; Field, J. H.; and Storch, H. H.), Pilot Plants — Fischer-Tropsch Oil Circulation Processes, Ind. and Engr. Chem. 42, 11, 2376-2384 Nov., 1950

Benson, R. E., (Cairns, T. L.), Some New Reactions of Cyclooctatetraene, J. Am. Chem. Soc. 72, 5355-6, Dec., 1950

Berg, Clyde, (Manders, Martin and Switzer, Robert), Generalized Correlation of Process Variables, Chem. Engr. Prog. 47, 1, 11-18, Jan., 1951

Berg, Clyde, Modern Advancement in Hypersorption Design, AIChE, Regional Meeting, Kansas City, Mo., May 13-16, 1951

Berg, E. H., (Corner, Eugene S.), The Relative Economics of LPG, Gasoline, and Diesel Fuel in Trucks and Buses, API, Mid-Year Meeting, Div. of Refining, Mayo Hotel, Tulsa, Okla., April 30-May 3, 1951

Bergen, Richard C., Tax Considerations in the Creation and Transfer of Oil and Gas Interests, Calif. Oil World, 3-11, 1st issue, Sept., 1950

Berger, Charles V., (Haensel, Vladimir), Aromatics by Platforming, Petr. Processing 6, 3, 264-267, March, 1951

Berliner, E., (Berliner, F.), Hyperconjugation. V. Relative Rates of Bromination of t-Alkylbenzenes, J. Am. Chem. Soc. 72, 3417-20, Aug., 1950

Berliner, F., (Berliner, E.), Hyperconjugation. V. Relative Rates of Bromination of t-Alkylbenzenes, J. Am. Chem. Soc. 72, 3417-20, Aug., 1950

Bernard, George G., Problems Encountered in Conditioning Water for Subsurface Injection, Oil and Gas J. 49, 23, 101-102, 105, Oct. 12, 1950

Berry, Clifford, (Robinson, Charles F.; Washburn, H. W.; and Perkins, George D.), A Mass Spectrometer for Monitoring Continuous Processes, ISA, National Instrument Conference, Buffalo Memorial Auditorium, Buffalo, N. Y., Sept. 18-22, 1950

Bertsch, Frederick, (Hershberg, E. B.; Kaplan, Herbert; and Brown, H. C.), Low Pressure Rotary Hydrogenator, Ind. Engr. Chem. 42, 2336-9, Nov., 1950

Best, H. W., (Gibson, H. J. and Taylor, J. E.), Octane Needs of Postwar Cars, SAE J. 59, 23-6, Feb., 1951

Bielstein, W. J., (Eckel, John R.), Nozzle Design and Its Effect on Drilling Rate and Pump Operation, API, Spring Meeting, Southwestern Dist., Div. of Prod., Hotel Beaumont, Beaumont, Tex., March 7-9, 1951

Bilhartz, H. L., High Pressure Sweet Oil Well Corrosion, NACE, Annual Conference and Exhibition, Hotel Statler, New York, N. Y., March 13-16, 1951

Binckley, C. W., (Hinton, C. H.), Special Discussion of Gas Well Testing, IOCC, Summer Meeting, French Lick Springs Hotel, French Lick, Ind., Aug. 3-5, 1950

Binder, George G., (White, Robert R.), Synthesis of Methane From Carbon Dioxide and Hydrogen, Chem. Engr. Prog. 46, 11, 563-574, Nov., 1950

Bircher, J. R., (Dressler, R. G.), The Bureau of Mines Gas-Synthesis Demonstration Plant at Louisiana, Missouri, ASME, Petr. Mechan. Engr. Conference, New Orleans, La., Sept. 25-28, 1950

Bird, F. S., (Toler, Jack), Corrosion Problems in Off-Shore Petroleum Operations, NACE, Annual Meeting, South Central Region, Rice Hotel, Houston, Tex., Oct. 9-10, 1950

Bishop, F. W., Photometer for Electron Microscope, Electronics 23, 110-11, Sept., 1950

Bishop, Louis C., (Liddell, Robert W.), Use and Misuse of Organic Water Conditioning Materials, Midwest Power Conference, Sherman Hotel, Chicago, Ill., April 4-6, 1951

Black, R. W., (Myers, J. H.; Hightower, C. L.; Wilson, W. O.; and McKenzie, J. H.), Establishing and Maintaining an Effective Fire-Control and Safety Program, API, Annual Meeting, Biltmore and Ambassador Hotels, Los Angeles, Calif., Nov. 13-16, 1950, (a panel discussion)

Blair, Charles M., Jr., Some Applications of Organic Corrosion Inhibitors in the Petroleum Industry, NACE, Annual Conference and Exhibition, Hotel Statler, New York, N. Y., March 13-16, 1951

Blair, P. M., (Osoba, J. S.; Richardson, J. G.; Kerver, J. K.; and Hafford, J. A.), Laboratory Measurements of Relative Permeability, AIMME, Petr. Br., New Orleans, La., Oct. 4-6, 1950

Blazer, Paul G., Independents Help Keep Oil Industry Competitive, Petr. Refiner 29, 6, 63-65, June, 1950

Bliss, Jack E., (Locke, L. C., Core Analysis Technique for Limestone and Dolomite, World Oil 131, 4, 204-207, Sept., 1950

Blohm, C. L., (Riesenfeld, F. C.), Corrosion in Amine Plants, ASME, Annual Petr. Mechan. Engr. Conference, Roosevelt Hotel, New Orleans, La., Sept. 24-28, 1950

Blohm, C. L., (Frazier, H. D.), Don't Let This Happen to Your Cooling Tower, Chem. Engr. 57, 9, 140, Sept., 1950

Bloomquist, W. C., Grounding of Industrial Systems, Midwest Power Conference, Sherman Hotel, Chicago, Ill., April 4-6, 1951

Blount, W. I., Two-Way Radio Expedites Colorado Interstate Operations, Oil and Gas J. 49, 50, 235-236, April 19, 1951

Blue, R. W., (Holm, V. C. F.), Hydrogen-Deuterium Exchange Activity of Silica-Alumina Catalysts, Ind. and Engr. Chem. 43, 2, 501-505, Feb., 1951

Blue, R. W., (Engle, C. F.), Hydrogen Transfer Over Silica-Alumina Catalysts, Ind. and Engr. Chem. 43, 2, 494-501, Feb., 1951

Blumer, A. F., How to Control Welding Quality in a Petroleum Refinery, Oil and Gas J. 49, 24, 94, 96, 101-102, 105, Oct. 19, 1950

Blumer, A. F., Welding Quality Control in a Petroleum Refinery, ASME, Annual Petr. Mechan. Engr. Conference, Roosevelt Hotel, New Orleans, La., Sept. 24-28, 1950

Boas, Arnold, (Benedict, Manson), Separation of Gas Mixtures by Mass Diffusion, Part II, Chem. Engr. Prog. 47, 3, 111-122, March, 1951

Boatwright, John W., Competition Insures Preparedness, Joliet Rotary Club, Joliet, Ill., Oct. 17, 1950

Boatwright, John W., The Petroleum Jobber in a Mobilization Economy, Indiana Independent Petr. Assn., Inc., South Bend, Ind., April 25, 1951

Bobrowski, F. P., (Cook, Alton B. and Spencer, G. B.), Special Considerations in Predicting Reservoir Performance of Highly Volatile Type Oil Reservoirs, AIMME, Petr. Br., New Orleans, La., Oct. 4-6, 1950

Boedecker, E. R., (Lynch, C. C.), The Solubility of Hydrogen Bromide in Normal Paraffin Hydrocarbons, J. Am. Chem. Soc. 72, 3234-6, July, 1950

Boggess, Henry, The Prevention of Accidents in Natural Gasoline Plants, NGAA, Permian Basin Regional Meeting, Settles Hotel, Big Spring, Tex., Feb. 23, 1951

Boner, C. J., Influence of Chemical Structure of Lubricating Oil on the Manufacture of Lubricating Grease, NLGI, Annual Meeting, Edgewater Beach Hotel, Chicago, Ill., Oct. 30-Nov. 1, 1950

Bonner, Z. D., (Seidel, Arthur H.), Inventions and Patents, Part I, Petr. Refiner 29, 6, 99-102, June, 1950

Booser, E. R., (Hersh, R. E.; Fenske, M. R.; and Koch, E. F.). Ring Analysis of Hydrocarbon Mixtures, J. of the Institute of Petr. 36, 322, 624-668, Oct., 1950

Borden, Guy, Jr., (Rzasa, Michael J.), Correlation of Bottom Hole Sample Data, J. of Petr. Technol. II, 12, 345-348, Dec., 1950

Boswell, B. Clifford, (Chu, Ju Chin; Donovan, J. Richard; and Fuhrmeister, L. Charles), How to Estimate Plate Efficiency, Part 2, Petr. Processing 6, 2, 154-157, Feb., 1951

Botset, H. G., Current Status of Secondary Recovery Research, Pennsylvania Grade Crude Oil Assn., Pittsburgh, Pa., June 15, 1950

LAUGH with BARNEY

One day Winston Churchill was being bedeviled by a persistent critic, who loftily declared: "I am a firm believer in fighting the enemy with his own weapons."

"Really?" Mr. Churchill replied, puffing deeply on his inevitable cigar. "Tell me, how long does it take you to sting a bee?"

* * *

Mother (trying to induce little daughter to go to bed early): Why, even the wee little chickens go to bed at sundown.

Little Daughter: Yes, but the old hen goes with them.

* * *

A group of doctors were sitting around a conference table, and discussing subjects of recent interests, such as the ethical question of how to treat hopeless and helpless sufferers. The subject of so-called "mercy killings" was given some attention.

Then someone raised the subject of what to do about babies that are born mentally deficient, or hopeless idiots. Should a battle be made to save such babies, or should they be allowed to pass away? There were adherents to both sides of the discussion. One doctor spoke up strongly for saving mentally deficient babies, no matter how hopeless their cases might seem. He thought they should be given a chance to live.

"What the hell?" he argued. "They could always do something! If the worst came to the worst they could play Canasta."

* * *

A contractor went out to look over one of his postwar homes. Walking up to a house in which a carpenter was working, he whispered: "Can you hear me through this wall?"

"Yep!"

"Can you see me?"

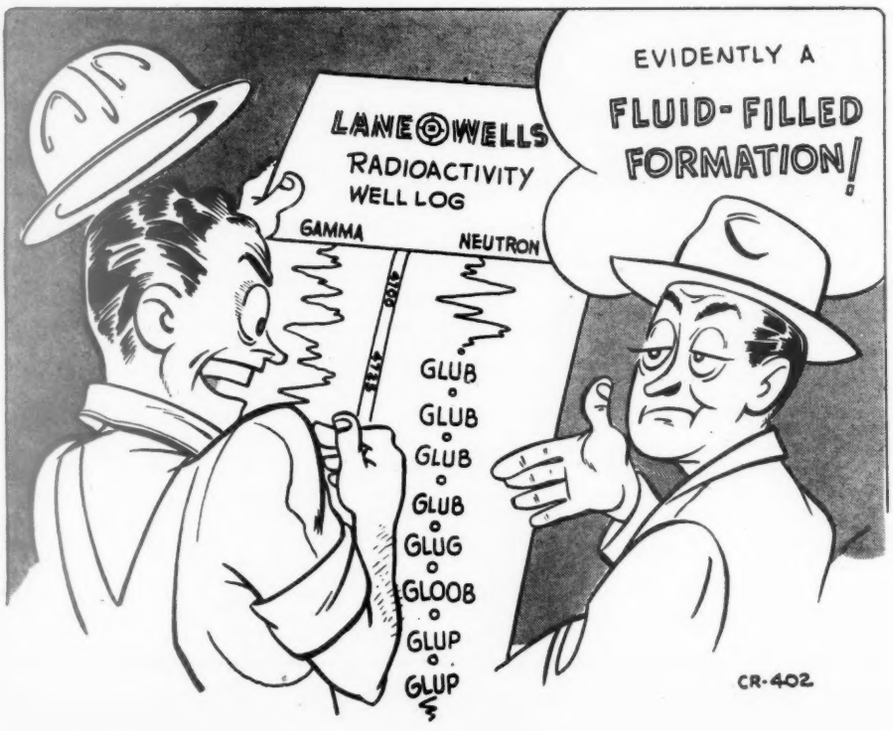
"Not very well."

"That," said the contractor jubilantly, "is what I call a darned good wall."

* * *

A young woman just home from college for summer vacation and very enthusiastic about the benefits of physical culture, said to her father: "Just watch this exercise. To develop the arms, I grip the rod by one end and move it slowly from left to right."

"Well, well!" exclaimed the father. "What won't science discover next! If that rod had straw on the other end you'd be sweeping."



The owner of a new Oldsmobile was very much impressed by the salesman's assertion that it would easily pass 100 miles per hour and ease on up to 120. He was preparing to test the truth of this statement on a long stretch in the country one day when an old fellow in an A-model flagged him down. "Well," said the old timer, "I wuz fixin' to ax ye if yeed push me into the service stashun but I guess ye wouldn't wanna run the risk of scratchin' ye new car." But after telling the fellow he had a long chain, the fellow agreed to tow him in. Going on down the road, the fellow kept thinking of what speed his car would get and forgot the A-model being towed behind. Quickly he sped up to 60 to 80 and gradually eased by the 100 mark. In the distance behind a cop's siren began screaming. Failing to catch up with the speeding cars, the cop soon pulled over to the side of the road and notified the next station up the road that a maniac was speeding that way and to be careful in catching him. "But the damnable part of it is," he shouted, "there's a fellow in an A-model behind blowing his horn and screaming to pass."

* * *

An elderly Indian was about to be converted to Christianity and had been attending the mission church for several weeks. Suddenly he stopped going. The Missionary, seeing him one day, asked, "Sam, aren't you going to come to church any more?"

"Don't think so."

"What's the matter?"

"That man Jesus all time broke."

* * *

"You've read the quotation wrong. Miss Adams," said the professor. " 'All men are created equal,' is the quotation, not 'All men are made the same way'."

* * *

St. Peter and St. Thomas Aquinas were playing golf one heavenly afternoon and St. Peter's first drive was a hole in one. St. Thomas stepped to the tee and also scored a hole in one.

"All right, now," said St. Peter, "let's cut out the miracles and play golf."

* * *

We like the story about Louis Mountbatten who, while making an inspection tour of his command in the China-Burma-India theatre, stopped at an outpost to talk with a colored soldier.

"Are you Indo-Chinese?" asked Lord Louis.

"No, suh," replied the GI, "Ah's out-doah Alabaman."

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OIL AND GAS TRADE NEWS

Rockwell Reports Industry Improved in South America

W. F. Rockwell, Jr., president of Rockwell Manufacturing Company has just returned from a three-week trip to South America where he took a close look into the market potential for the international division of his company. He contacted the major oil companies in Venezuela to discuss their future plans and requirements. In 1941, Rockwell represented his company on an industrial exploration tour of six South American countries.

W. F. Rockwell

"I was amazed at the industrial progress of the last decade," he said. "Their manufacturing and materials handling techniques are vastly improved since that first visit—and labor seems more skilled and better trained."

Cleco Names Agents

The Cleco Division of the Reed Roller Bit Company, Houston, Texas, has announced the appointment of House of Pfaff, Inc., 10-36 49th Avenue, Long Island City 1, New York, as distributors of Cleco products in that area. Pfaff will handle the complete lines of Cleco and Dallett air tools and accessories.

Oil Well Supply Opens Garland Plant to Visitors

Several hundred customers and friends got a first-hand look at the operations of Oil Well Supply Company's warehouse and modification center at Garland, Texas, when the U. S. Steel subsidiary held open house at the new service unit recently.

Executive staff members and other officials from the Dallas headquarters, headed by President Fred F. Murray, toured visitors through the 75,000 sq ft building, which will serve every major oil field in the Southwest on a 24-hour basis.

The warehousing section of the new center, equipped with 5000 bins for small parts and miscellaneous merchandise, provides back-up stocks of spare parts, equipment and service for "Oilwell's" 49 field stores in Texas, Oklahoma, New Mexico, Kansas, Arkansas, Louisiana, and Miss.

New Texas Plant

The Big Three Welding Equipment Company opened new headquarters this month in Houston, Texas, from which it can expand its services to the oil and gas industries and other industries in the Southwest. The firm, manufacturers of oxygen and dealers for The Lincoln Electric Company of Cleveland, Ohio, pioneered welding in the oil and gas fields in the 1920's. In its first year, 1920, it supplied and serviced industry with $30,000 worth of equipment and last year with over $12,000,000.

More Than 8000 Men Attend Diesel Classes

Detroit Diesel Engine Division of General Motors reports that during a two-year period just ended more than 8000 engine owners and mechanics attended classes in diesel engine operation and maintenance offered by the division's three mobile training schools. The sessions were held in on-the-job locations at construction sites, mines, oil fields, lumbering camps, and GM diesel distributors' headquarters throughout the country. According to T. L. Guarniere, service training director, the division's product training program had its origin during World War II when Detroit Diesel conducted extensive training programs for military personnel in the operation and proper maintenance of the 2-cycle diesel engine.

National Supply Offices Move to New Building

The National Supply Export Corporation which, for the past 17 years has had offices at 30 Rockefeller Plaza, New York City, has announced its new location in a new building at 600 Fifth Avenue, corner of 48th Street. Also moving will be the New York office of the Spang-Chalfant Division of The National Supply Company, and the Export Department of the Engine Division of National Supply. Expanded operations of the Export Corporation made it necessary to find additional office space.

Form Refractories Group

A new trade association known as The Refractories Institute has been formed by the members of the refractories industry. Purpose of the institute is to promote demand for the products of the industry, spur additional research with the objective of still further improving products and processes and cooperating with government agencies in the interest of the public and the industry. Approximately 40 corporations representing the major portion of the industry have joined the new association, it was announced. It was also announced that James L. Crawford of Walsh Refractories Corporation, and W. A. Turner of the McLain Fire Brick Company, have been elected president and treasurer respectively.

D. V. Carter, petroleum engineer, Magnolia Petroleum Company, watches as Alex Quale demonstrates mechanical scale model of the 133-ft portable steel derrick at Oilwell's open house in Garland, Texas. Others are John W. Wagner, Texas Mid-Continent Oil and Gas Association, and John E. Miller, manager of machinery service.

LeTourneau to Build Texas Steel Mill

R. G. LeTourneau, Inc., earthmoving equipment manufacturer, Peoria, Illinois, has begun construction of its own steel mill at its plant at Longview, Texas. An approved Certificate of Necessity for construction has been granted LeTourneau by the National Production Authority. The mill is expected to be in operation by the end of this year, and will be capable of turning out 1000 tons per day of finished steel plate 144 in. wide, ranging in thickness from 3/16 of an inch to 12 in.

Marcus to Add Annex

The rapid growing demand for Marcus transformers and the need for increased production facilities has prompted the Marcus Transformer Company, Hillside, New Jersey, to add an annex to its present plant. The new one-story brick building will extend its productive space by 50 per cent.

B and W Agents Named

Kenneth A. Wright of B and W Inc. has recently returned to Huntington, California from Canada, where Import Tool Company, Ltd., Calgary, has been selected as Canadian distributor for B and W scratchers and centralizers. Import Tool Company is owned and operated by Delbert D. Lewis and his son, D. D. Lewis, Jr.

Another scratcher and centralizer distributor is James E. Enrick Company of Casper, Wyoming, who was recently named Rocky Mountain agent.

The company also announced that field warehouse stocks of B and W scratchers and centralizers have been established at the Vacuum Truck Service Company, C. A. headquarters in El Tigre, Venezuela. This company is owned and operated by Jack Bryan.

Raytheon Moves Sales Offices

The Raytheon Manufacturing Company, Waltham, Massachusetts, announces the transfer of its New York and International sales offices to 19 Rector Street, New York 6, New York. The telephone number, Whitehall 3-4980 and cable address, RAYTHEONEX, New York, remain unchanged. This new location offers many advantages to Raytheon's dealers and customers both abroad and in the New York sales district. Raytheon products represented include the "Mariners Pathfinder" radar, "Fathometer" echo depth sounders, Radiotelephones and other equipment.

National Carbon Given Top Safety Honor

The National Safety Council has granted its highest honor, The Distinguished Service to Safety Award, to National Carbon Company, a division of Union Carbide and Carbon Corporation, makers of "Eveready" and "Prestone" products. The award is in recognition of the firm's record in reducing employee accident rates each year for four consecutive years. It was formally presented to J. M. Spangler, president of National Carbon Company, by N. H. Dearborn, president of the Council. The company's accident rate, embracing employees at 21 plant locations, was only ¼ the 1947-1949 national average for all industries, and slightly over ½ the rate for comparable industries.

A. O. Smith Division Adds Four Laboratories

Facilities of the product service division of A. O. Smith Corporation have been expanded to include 4 fully equipped laboratories in addition to a classroom. The labs serve in the field of domestic water heating, volume water heating, house heating, and electric motor service. Newest of the additions is a heating equipment room containing working installations of various models and sizes of A. O. Smith heating equipment, and examples of typical heat radiation such as hot water baseboard, standing floor convector, and radiant tubing.

York Company Appoints Pacific Sales Engineers

Otto H. York, president of the Otto H. York Company, Inc., announces the appointment of Jacobs Engineering Company, Los Angeles, California, as sales engineers for Pacific Coast region. Under the direction of Joseph J. Jacobs and Harry Vinoch, the organization will handle all Pacific Coast sales and engineering for the York line of wire mesh entrainment separators, and mist extractors, wire barriers, etc., used in the petroleum and allied industries.

Graham Forms Agency

By mutual agreement, the former partnership of Dozier-Graham-Eastman is being altered, with Graham leaving to form his own agency, and Dozier and Eastman continuing the former organization intact. New name of this long-established organization is now Dozier, Eastman and Company. Other than Graham's no longer being connected with the company, no other changes are being made.

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To obtain more information on products advertised see page E-33

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Keeping equipment *on the job* is of prime importance today—to the nation as well as the oil industry. Making hole, laying pipe—it's a big, vital job that's getting bigger and more essential than ever as the nation builds its military strength. This year calls for 45,000 producing wells —171 *million* feet of hole. Seven million barrels a day are needed to power industry and the military machine.

Right now there is a shortage of material with which to build urgently needed machines and parts. Military and Defense Rated Orders get the nod over unclassified civilian needs. Steel and other materials are in short supply. This means that you—with our help—must get every last machine-power hour out of the equipment and parts you now have.

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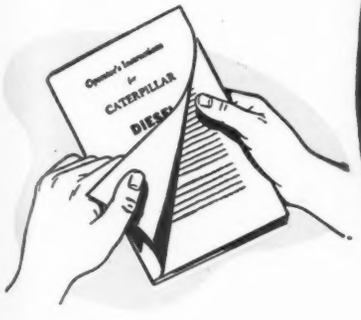
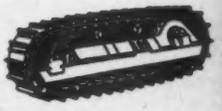


• DUST

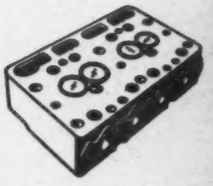
Think of dust as Machine Enemy No. 1. A few grains today—a few more tomorrow—and soon the result adds up to serious wear. Dust or dirt plugged breathers or air cleaners—use of dirty oil containers—loose intake manifolds—loose inspection covers—dirty clutch compartment—failure to wash flywheel clutch compartment—worn seals on crankshaft—defective gaskets—failure to clean oil filter openings . . . these are some of the vulnerable spots.

• TRACK ASSEMBLY



Don't let abusive use or neglect cripple the service life of your track assembly. Track adjustment and lubrication of rollers, carrier rollers and idlers are your job. Before excessive wear occurs on grousers, links, pins, bushings, idlers, rollers and sprockets, call in your "Caterpillar" dealer. He can build up grousers, rollers, idlers and links, and replace sprocket rims and turn pins and bushings so you will have many additional hours of service.

• CYLINDER HEADS

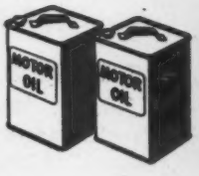


Prevent cracked cylinder heads by avoiding overheating, freezing, scale deposits, filling a hot engine with cold water, pulling heads down too tight, and other poor maintenance practices. Your "Caterpillar" dealer can repair most cracked cylinder heads. He can replace worn valve seats with valve inserts and restore the rocker arm mechanism to serviceable limits. Consult your Operator's Instruction Book for proper cooling system and valve care.

• COOLING

Don't let your engine overheat. Keep the cooling system free of scale, rust and sediment. Use soft or treated water, and when freezing temperatures exist, protect your engine with anti-freeze. Clean the radiator regularly with chemical flushing solutions. Remove foreign matter from the core by brushing or washing. Prevent engine troubles which come with overheating. Consult your Operator's Instruction Book for proper cooling system care.

• LUBRICATION



Careful lubrication practices will add much to your satisfaction through equipment performance, economy and long life. Use *only* recommended lubricants, changing the lubricant at proper intervals. And use *only* "Caterpillar"-proved filter elements. Remove dirt from fittings and clean around the crankcase filler cap before adding oil. A little care saves many hours of engine life. Consult the lubrication chart in your Operator's Instruction Book.

• PISTONS AND LINERS

Almost all the piston wear occurs in the upper ring groove. Your "Caterpillar" dealer can renew your pistons by machining the upper ring groove for a wide ring, many sizes of which are chrome plated. Worn liners can be deglazed and put back to work for many additional hours of service life. Consult your Operator's Instruction Book for information on lubrication and the oil cooling system.

CATERPILLAR

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DIESEL ENGINES • TRACTORS • MOTOR GRADERS • EARTHMOVING EQUIPMENT

New Mexico Store Opened

A new operating station has been opened in Aztec, New Mexico, by Dowell Incorporated, a nationally known firm specializing in servicing the petroleum industry.

Harry A. Riggs, Dowell sales engineer from Seminole, Oklahoma, has been transferred to Aztec, a part of Dowell's Midland, Texas district. A graduate in petroleum engineering from the University of Tulsa, Riggs has been with Dowell since 1948. Other personnel in the Aztec Station will include Floyd Bushwar, C. E. Cole, and R. A. Duncan.

Oklahoma Supply Store

To serve the huge Burbank field in Oklahoma's western Osage County, The National Supply Company has announced the opening of an oil field supply store at Shidler, Oklahoma. The store has been built one-quarter mile south of the Shidler city limits. It will be divided into two parts, with the front half serving as a sales room. Warehouse with provision for servicing down well pumps will be at the rear of the sales room. Glenn L. Gordon will manage the store.

Retirement Plan Set Up

Foster Wheeler Corporation has submitted a non-contributory retirement plan covering all of its employees to the Wage Stabilization Board for approval, the company announced. The plan, which provides for retirement at the age of 65 on an income computed on the basis of $1.50 per month for each year of credited service, will be paid for entirely by the company and is in addition to Social Security benefits. In order to protect employees whose Social Security will be relatively small the program calls for payments of at least $112.50 per month including Social Security for all employees having 25 years of service.

Dia-Log Opens Texas Office

B. R. McNulty, Vice-President and Manager of the Mid-Continent division of the Dia-Log Company announces the completion of Dia-Log's new Houston office and shop building at 3330 Old Spanish Trail. These facilities will serve both as Dia-Log's Mid-Continent division headquarters as well as the operating offices for the Houston district.

The opening of the Houston office makes a total of 16 offices where Dia-Log electric line truck services . . . including tubing and casing surveys, free point indicator service, back-off service, string shot jarring and perforation cleaning . . . are available.

Oklahoma Office Set Up

The Western Company, oil and gas well acidizing and perforating company of Midland, Texas, has established a gas well treating station at Guymon, Oklahoma. Merl Moore, formerly at Western's Ulysses, Kansas, station has been named manager of the new station. The Guymon station will operate under the Borger, Texas, district office which is managed by C. E. Inman.

Merl Moore

Calumet and Hecla Enters Steel Tubing Production

The Wolverine tube division of Calumet and Hecla Consolidated Copper Company has expanded into the field of steel tubing. An agreement has been concluded between Calumet and Hecla and the Karmazin Products Corporation of Wyandotte, Michigan, whereby the Wolverine Tube Division has exclusive rights to produce tubes by the patented forming and brazing processes of the Karmazin Products Corporation.

This exclusive license will increase Wolverine tube division's operations as the division will now be able to manufacture brazed tubes of both ferrous and non-ferrous metals.

Cummins Plans Expansion

Cummins Engine Company, Inc., Columbus, Indiana, has announced a major expansion of engine production capacity involving new facilities to cost $6,000,000. New facilities will increase production capacity at Cummins at least 50 per cent over the 1950 record high level. Irwin Miller, president of Cummins Engine Company, stated that the current expansion, to be completed in 2 years, is necessary if the company is to be in a position to supply the quantity of Cummins diesel engines required.

Atlas Plant to Expand

George L. Wirtz, president of The Atlas Mineral Products Company, has announced further expansion of the company's Houston, Texas, plant. The new construction will include a lining shop and storage facilities. Sheet rubber stock based on a large number of natural and synthetic rubber compositions will continue to be calendered at the Mertztown, Pennsylvania plant, but all types of linings will be installed at the Texas plant.

Foxboro Expands Plant

A new one-story building, now nearing completion, will add 50,000 sq ft, or an increase of nearly 25 per cent, to the working area in the headquarters of The Foxboro Company, Foxboro, Massachusetts, maker of industrial instruments for measurement and control. It is so situated as to be a connection, on the same floor level, between the present factory buildings and a new steel and aluminum warehouse, 50 by 200 ft, recently completed. The new building will be used principally for the final assembling and testing of recorders and controllers for temperature, pressure, liquid level, and flow; and the transfer of these operations from the older buildings to the new one will permit expansion of departments that produce electronic and electric instruments and control equipment of other descriptions.

Canadian Agents Named

The Well Instrument Developing Company has announced the appointment of Southwestern Industrial Electronics Company, 434 7th Avenue E, Calgary, Alberta, Canada, as its representative in Canada. SIE will handle the sale and repair service of WIDCO electric loggers. The Canadian branch of SIE is headed by Emmet House who has been engaged for many years in the exploration business. Widco Loggers are designed to give electric logs in core holes, shot holes, water wells and shallow production wells where a two-curve electric log is sufficient.

NCA Iron Workers Meet

The National Constructors Association met with representatives of the International Association of Bridge, Structural, and Ornamental Iron Workers for a discussion of mutual problems at the bi-monthly meeting of the constructors in St. Louis, recently. The National Constructors Association is composed of contractors engaged on a national scale in engineering and construction of chemical plants, steel mills and oil refineries, projects which make extensive use of iron workers.

Sarco Gets New Offices

The Chicago, Illinois headquarters of Sarco Company, Inc., moved recently to a new address. Their present location is 322 West Randolph Street in Chicago. Main offices for the company, which manufactures steam specialties, is in the Empire State Building, New York City. George H. B. Burke is manager of the Sarco Mid-west headquarters.

Mission Equipment Will Distribute Mack Trucks

The Mission Equipment Company of Corpus Christi, Texas, recently held its opening as distributor of Mack trucks. Local officials, including Mayor Leslie Wasserman, truckers and oil field operators inspected the completely equipped service facilities and parts stock for over-the-highway and oil field trucks. With a large portion of southern Texas as its territory, Mission Equipment will shortly open another modern plant for Mack sales and service in San Antonio.

Chicago Offices Opened

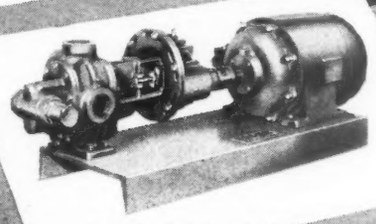
A 46,000 sq ft office was publicly opened recently in Chicago by the Westinghouse Electric Corporation. The new Westinghouse Northwestern district headquarters in Chicago's Merchandise Mart features: (1) fluorescent sunlamps; (2) germ-killing Sterilamps installed in the ventilating system; (3) acoustical soundproofing, modern fluorescent lighting, and complete air conditioning. New type fluorescent sunlamps developed by Westinghouse are installed in the general offices where they produce in an 8-hour day the equivalent of 15 minutes of summer sun. These lamps provide the nearest thing to actual ultraviolet content of sunlight.

B. F. McDonald, center, congratulates Glenn McCarthy on speech. Looking on is Miss Gwenn Caldwell, "McDonald Safety Girl."

McDonald Company Plant Holds Formal Opening

The formal opening of the new quarter-million dollar B. F. McDonald Company industrial safety equipment and safety clothing plant in Los Angeles, California, was marked by a full hour telecast during the celebrations. More than 1000 guests were at the plant to watch the show being televised. The show, entitled "The Little Man Who Wasn't There," contained a documentary account of the famous Argonaut gold mine disaster, which claimed the lives of 47 miners in 1922, a tragedy in which B. F. McDonald, head of the McDonald Company, was captain of one of the U. S. Bureau of Mines rescue teams. Glenn McCarthy gave the main address.

EFFICIENCY + PLUS



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TRADE PERSONALS

H. P. Boncher

▸ **Hector P. Boncher** has been elected general manager, Dresser Manufacturing Division, one of 10 operating companies of Dresser Industries, Inc., Dallas, Texas, as a vice president of Dresser Industries, Inc. Boncher was born in Luxemburg, Wisconsin, in 1904. He holds a degree of commercial engineer from the University of Cincinnati, which he attended from 1923 to 1928. He was appointed assistant sales manager of Dresser Manufacturing in 1930, sales manager in 1938, and general manager, the position he now holds, in 1942.

▸ **Harry A. Kieselbach,** general manager of the insulation department for Johns-Manville Sales Corporation until his recent retirement, has been retained as technical consultant to The Magnesia Insulation Manufacturers Association. Kieselbach had served as chairman of the association's technical committee since it was formed in 1945. In that capacity, he helped to plan and supervise its research activities and collaborated in the drafting of its technical literature.

▸ **Laurence R. Lee** has been appointed assistant to the manager of engineering for the General Electric Company's turbine divisions. He was previously assistant division engineer in the company's gas-turbine engineering division. He was graduated in 1922 from Washington State College, and joined General Electric in 1929 as an engineer in the Schenectady Works Laboratory.

▸ **Frank A. Davenport,** Owens-Illinois Glass Company, has been named Kaylo sales engineer in Atlanta, Georgia. He replaces **C. H. Ramien,** who is now acting as resident engineer at a Kaylo installation for Gulf Oil at Port Arthur, Texas, and is to receive a broader assignment to be announced at a later date. The Atlanta sales territory includes the states of North Carolina, South Carolina, eastern Tennessee, Georgia, Alabama, and Florida.

F. A. Davenport

▸ **A. F. White, Jr.,** has been appointed assistant district manager of The National Supply Company's Midland, Texas, district. He will make his headquarters at Odessa. **C. P. Triplitt** has been named store manager of the company's Odessa, Texas, store. Continuing in the capacity as district manager of the Midland district will be **E. M. Braselton,** Midland, Texas, who has been with National Supply since 1928. White joined National Supply in 1937. Triplitt joined the company in 1939.

J. E. Rovensky

C. J. Hardy, Jr.

▸ **Charles J. Hardy, Sr.,** has resigned as director, chairman of the board and a member of the executive committee of American Car and Foundry Company. **John E. Rovensky** was elected chairman of the board and **Charles J. Hardy, Jr.,** was elected chairman of the executive committee, combining that office with his present position as president. Rovensky became a director on July 11, 1940, and was elected chairman of the executive committee on April 1, 1944. President Hardy graduated from Williams College in 1917. In 1944 he began his present connection with the company. He has served as vice president and executive president, and in 1947 was named president.

▸ **John Fox,** formerly district manager for Machinery and Welder Corporation, has been named representative of the A. O. Smith welding products division in the greater St. Louis area.

▸ **W. W. Fischer** has been named sales manager of Hardesty and Company. Fischer has been associated with W. C. Hardesty for a good many years. A modern plant, situated in Philadelphia, Pennsylvania, for production of stearic acid, red oil, glycerine and various fatty acids, has just been completed, and the company is rapidly expanding.

W. C. Young

J. M. Monroe

▸ **William C. Young,** Nordberg Manufacturing Company sales engineer, has been transferred from Milwaukee, Wisconsin, to the company's Washington, D. C., office. **Joseph M. Monroe** will assume Young's duties as sales engineer in the Milwaukee office. Following his graduation from Marquette University in 1943, Young joined Nordberg in the heavy machinery division specializing in diesel engine applications. Monroe received his degree in mechanical engineering from North Carolina State College in 1946. He continued his engineering studies while serving as an instructor in mathematics at this school and in 1948 received his master's degree in diesel engineering.

▸ **Howard A. Kreith** has been named purchasing agent of Dearborn Chemical Company, manufacturers of No-OX-ID rust preventives and boiler feedwater treatment. Kreith formerly was a bulk chemical sales representative for McKesson and Robbins, Inc.

▸ **A. H. "Art" Knight,** sales manager for Franks Manufacturing Corporation of Tulsa, Oklahoma, is on an extended tour of Central and South American countries in the interest of export sales of Franks servicing and drilling rigs. He will visit: Venezuela, Colombia, Bolivia, Ecuador, Brazil, Peru, Argentina, Trinidad and Mexico.

▸ **E. W. Brockman** has been appointed division manager for Oklahoma, Kansas, and the Texas Panhandle, for Rector Well Equipment Company, Inc., Fort Worth, Texas. His headquarters are in Tulsa, Oklahoma. Upon graduation from the University of Oklahoma, Brockman spent 3 years doing survey work in Southern Louisiana for Petty Geophysical Engineering Company. In 1936, he joined Rector Well Equipment Company, Inc., as sales representative in Oklahoma.

E. W. Brockman

J. F. Donnelly was recently named assistant manager of the water heater division of A. O. Smith Corporation, manufacturers of Permaglas and Duraclad domestic water heaters. Donnelly's appointment, announced by F. S. Cornell, follows Cornell's recently announced assignment as group executive over the water heater division at Kankakee, the heating division at Toledo and the Eastern motor division at Tipp City, Ohio. Donnelly announced that **S. E. Wolkenheim,** former supervisor of electric water heater sales, will succeed him as marketing director of the division.

H. H. "Pete" Peters, vice president of Technical Oil Tool Corporation, has announced several changes in the Totco organization. Peters stated that **Bob Green,** who has been stationed at Casper, Wyoming, recently moved to Los Angeles to become field testing engineer for Totco. **Eldon Snyder,** formerly at Brookhaven, Mississippi, has taken over Bob Green's former territory in Casper. **Howard Reed,** formerly in Houston, moved to Laurel, Mississippi, to serve this area. At Houston, **W. D. "Shorty" Smith** has joined the Totco organization, and was assigned the territory vacated by Howard Reed. Smith formerly worked in Longview, Texas, and Shreveport, Louisiana.

H. H. Peters

N. A. (Lee) Guill was named division manager of Chiksan Company's Chicago, Illinois, branch office and sales supervisor of the Chicago district, with offices at 122 South Michigan Avenue, Chicago. He has been Chiksan sales representative in the Chicago territory for the past several years. **W. L. Clark** has been appointed Chiksan sales representative in the Chicago territory and assistant to Guill.

Wilmot F. Wheeler has been elected chairman of the board of directors of American Chain & Cable Company, Inc., and will continue as its chief executive officer. **Cyrus N. Johns** has been named president, and **Colonel Harry D. Weed,** the inventor of the Weed tire chain, has been added to the board of directors. Wheeler, who succeeds **Walter B. Lashar** retiring because of ill health, has been president of the company since 1946.

L. O. Gore

J. E. St. Clair

L. O. "Red" Gore has been named Western Kansas district sales manager for The Western Company, oil and gas well acidizing and perforating company of Midland, Texas. Gore was formerly sales representative for Western's north district with headquarters in Lubbock. He joined Western's sales staff 3 years ago. **Jim L. Myers** is The Western Company's district sales manager for Texas-Oklahoma Panhandle and maintains his office in the company's district offices in Borger.

J. E. St. Clair of Los Angeles has been appointed as agent for W-K-M Company in the states of California, Washington, and Oregon. St. Clair has long been associated with a former agent of the W-K-M Company, **Gene McIntyre,** who passed away April 5.

Dr. Edwin Wetterstrom has joined the research and development staff of Graver Tank and Manufacturing Company, Inc., as analytical engineer. His duties are to pursue new and independent lines of research in problems of the storage of volatile liquids. These avenues are a continuation of his advanced work at Purdue University, where he held the Graver research fellowship and conducted theoretical and experimental investigations related to practical problems in new Graver projects. He has had extensive experience in the design of pressure vessels and steel structures, and has been the author of several important articles on engineering design, published in professional journals.

E. Wetterstrom

Alvin R. Kuder has been elected vice president in charge of manufacturing of OPW Corporation, Cincinnati manufacturers of valves, fittings, and assemblies for handling hazardous liquids. Kuder has been with OPW Corporation since 1930, as engineer, assistant superintendent of the valve department, as head of production scheduling and inventory control, as general plant superintendent, and as works manager.

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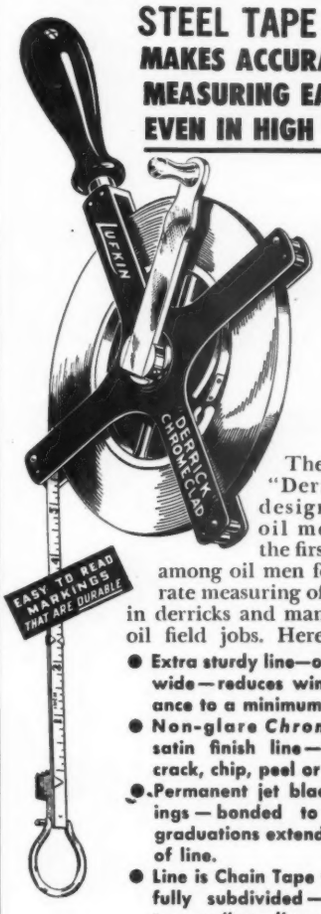
MAKES ACCURATE MEASURING EASY... EVEN IN HIGH WIND



The *Lufkin* "Derrick" — designed by oil men — is the first choice among oil men for accurate measuring of casings in derricks and many other oil field jobs. Here's why:

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- **Non-glare *Chrome-Clad* satin finish line—will not crack, chip, peel or corrode.**
- **Permanent jet black markings—bonded to steel—graduations extend to edge of line.**
- **Line is Chain Tape weight—fully subdivided—"Instantaneous" readings.**
- **Oversize drum increases winding speed. Long handle gives extra leverage—line locking type.**
- **Substantial, 4-arm frame has tape roller in each arm. Tape removable from frame.**
- **Improved pattern finger rings. Patented reinforcing strip prevents kinking and first end breakage.**
- **Hook is securely riveted to lip of detachable, swinging ring.**

In 100-ft., 150-ft. and 200-ft. lengths marked feet, 10ths and 100ths; or feet, inches and 8ths. See them at your Supply House. 87

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TAPES · RULES · PRECISION TOOLS

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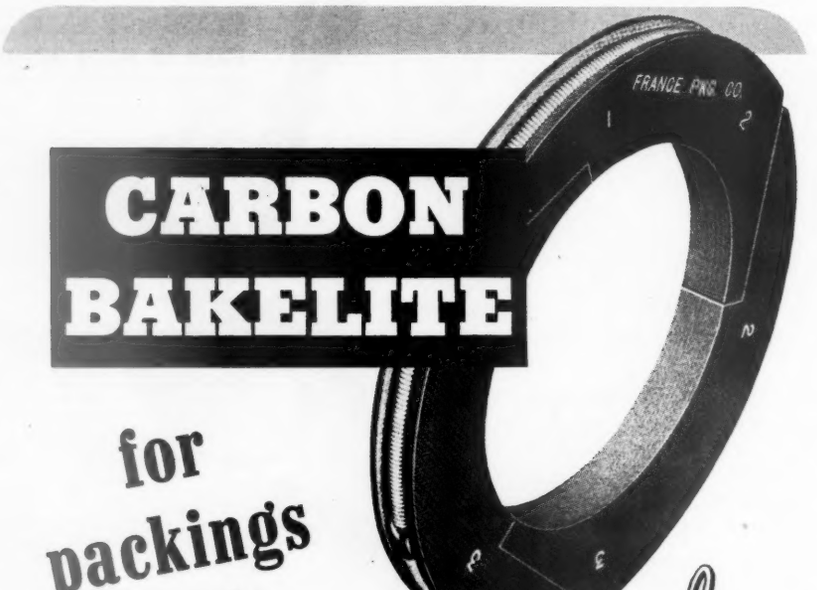
John W. Gates has been appointed sales manager of Well Equipment Manufacturing Corporation, Houston, succeeding **Tracy T. Word, Jr.**, resigned. Gates' appointment to his new position follows a succession of promotions since he joined the company in 1946 after 4 years' service with the Navy. Early in 1950 he was appointed assistant sales manager, a position he is vacating to become sales manager.

J. W. Gates

William E. Hoard has been appointed manager of the new Western Gear Works plant at Belmont, California. **Ray Conlisk** has been promoted to the position of supervisor of the application engineering department at Pacific Gear and Tool Works, San Francisco. Hoard was graduated in mechanical engineering from the University of Washington and trained in works management by Westinghouse Electric. He joined Western Gear in 1942. Conlisk joined Pacific Gear and Tool Works in 1946. He is a native San Franciscan and an engineering graduate of the University of California at Berkeley.



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FRANCE PACKING CO.

PHILA. 35, PA.

Charles Glocke

Charles Glocke, who has served as Four Wheel Drive Auto Company's field service manager for the past six years, has been named manager of the FWD's service division. Glocke has been permanently employed by the company since early in 1934. He has been field service manager since 1945.

Ralph W. Rausch has been appointed consulting engineer of Link-Belt Company, manufacturers of materials handling and power transmission machinery. His headquarters will continue to be at the Pershing Road plant, Chicago, of which he became assistant chief engineer in 1933 and chief engineer in 1947. **Joseph J. Richard,** heretofore executive assistant chief engineer of the Pershing Road plant, has been appointed chief engineer of this plant to succeed Rausch. He joined Link-Belt in 1913.

William H. Feathers, general superintendent of the Niagara Falls Works of National Carbon Company, a division of Union Carbide and Carbon Corporation, has been awarded an Alfred P. Sloan Fellowship for executive development, at Massachusetts Institute of Technology. The fellowship provides for an intensive one-year program of study of the problems of business management, of industrial and human relations in industry, and of the responsibilities of industry to national and international problems. Feathers was graduated from Virginia Polytechnic Institute with a BS degree in chemical engineering. He joined the National Carbon staff at Niagara Falls in 1937.

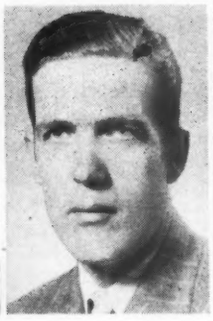
W. H. Feathers

V. C. Gallman, former district representative in Tulsa, Oklahoma, has been transferred to Houston, Texas as general sales representative. Gallman will supplement W-K-M Company's representative in Houston and will also represent the company in the interest of pipe line sales in the central United States district.

V. C. Gallman

To obtain more information on products advertised see page E-33

O. F. Dickinson



T. J. Plummer

T. J. Howard

C. E. Wright

O. F. Dickinson has been named president and treasurer of Buda Engine Sales and Service, Inc., Tulsa, Oklahoma. Other new appointments are: **T. J. Plummer,** vice president in charge of store operations and service; **Thomas J. Howard,** general sales manager, **L. G. Burkett,** secretary, and **L. R. Whitefield,** assistant treasurer and assistant secretary. **C. E. Wright,** former vice president and general sales manager, resigned after 15 years with the company. Dickinson joined Buda in 1938 as secretary and treasurer and was also made vice president several years later. Plummer, a veteran employee of the company, came with Buda in 1935. He was Oklahoma City district manager before his promotion. Howard joined Buda in 1941 as a sales engineer and later was put in charge of priorities and war contracts. After the war he became assistant general sales manager.

Gordon L. Chapman was elected president of the Carver Pump Company, Muscatine, Iowa, and **Roy J. Carver,** founder of the company, was elevated to chairman of the board. Chapman joined the company in 1948 as comptroller. In July of that year, he was elected vice president and a director. He is a graduate of Illinois, 1935. The company also announced the election of **Alexander A. Zuber,** plant manager, as a vice president and a director. Zuber graduated from Illinois Institute of Technology and has been Carver plant manager since 1946.

C. C. "Red" Pryor has joined the W-K-M Company, Houston, Texas, in the capacity of process applications engineer, and will devote his efforts to business with the gas and gasoline plants, refineries, and petrochemical phase of the oil industry. Pryor formerly was associated with *The Refiner* as associate editor, and has had many years experience in special and process application fields.

C. C. Pryor

L. M. Evans has been put in charge of the new Rochester, New York, branch office of Worthington Pump and Machinery Corporation, according to an announcement by W. H. Feldmann, vice president in charge of sales. The office is situated at 1246 Sibley Tower Building, Rochester 4. Evans received his B.S. degree in electrical engineering from the Cooper Union Institute of Technology in New York City in 1936. Subsequently he served the company as an assistant test engineer and general line estimator for and representative in St. Louis, Buffalo, and Syracuse except for four years of military service with the Army Signal Corps from 1941 to 1945.

R. L. Day

Walter Whiting

Robert L. Day was appointed to the position of factory sales engineer by General Controls and will make his headquarters at the Glendale plant. Day is no stranger to the West Coast firm, having spent the last year as senior sales engineer in the San Francisco factory branch office. In his new job, he will assist branch office personnel by handling technical inquiries from customers concerning heating, industrial, and refrigeration controls made by General Controls. He attended the University of California and University of Southern California.

Walter Whiting has been named Chicago, Illinois district manager of the John A. Roebling's Sons Company, Trenton, New Jersey. Whiting, who has been associated with the Roebling Company since 1929, began as a warehouseman in the Portland branch. He became a salesman in the Oregon territory in 1935, a position he held until his recent appointment.

JOHNSTON VERTICAL PUMPS...

JOHNSTON TURBINE PUMPS

- *Save on Power Costs*
- *Minimize Maintenance Expense*
- *Conserve Space*

Johnston Vertical Turbine and Propeller Pumps embody *so many* advanced features—features that save power, minimize maintenance, conserve space, and increase over-all operating efficiencies that they are literally revolutionizing pump performance standards in industry after industry. They are staying on the job longer with less upkeep. They are delivering *more volume* against *higher heads* at greatly reduced power costs. They are cutting floor space requirements as much as 60% over that required for other-type pumps. *And they are making many other vital savings!!!*

These are facts backed by in-the-field reports from hundreds of Johnston installations in many industries . . . facts you should investigate before your next pump purchase. Johnston engineers will supply you gladly with complete information on the savings you can expect from a Johnston Pump on your specific fluid-moving job.

A letter, wire or phone call will get prompt attention and action.

JOHNSTON PUMP COMPANY

3272 E. Foothill Blvd. Pasadena 8, Calif.

JOHNSTON LITTLE BEAVER PUMPS For 4" Minimum Well Size	JOHNSTON VERTICAL PUMPS For Volatile Fluids and Hot Liquids
JOHNSTON JUNIOR TURBINE PUMPS Big Pump Features and Small Pump Economy	JOHNSTON CLOSE COUPLED TURBINE PUMPS For Industrial Applications
JOHNSTON DEEP WELL TURBINE PUMPS Oil- or Water-Lubricated	JOHNSTON PROPELLER and MIXFLOW PUMPS For Large Capacity At Low to Medium Heads

To obtain more information on products advertised see page E-33

John Brennan, Fluid Packed Pump Company sales engineer, is on an extended business trip to South America. He will tour the Western Venezuelan fields and review operations at the Los Marchus pump service shop. From there he will go to Eastern Venezuela to assist National Supply of Venezuela personnel in opening a new downwell pump shop for servicing Oilmaster products. The last leg of his journey will take him to Peru, where he will study downwell pumping needs.

John Brennan

Charles L. White, has been named general manager of the Jarecki International Supply Division, H. K. Porter, Inc., which now includes the former Ideco Supply stores as well as the Jarecki stores. Other officers are: **John L. Morgan,** former district manager for Ideco in Louisiana and Mississippi named sales manager; **F. W. Budde** assistant treasurer; **J. A. Hadlow,** works accountant; **W. L. Reynolds,** purchasing agent; **E. H. Jaynes,** credit manager; **Don Shaw,** manager, machinery sales; and **F. E. Suder,** manager, pumping unit sales.

Boyd S. Oberlink has been named vice president of the Allis-Chalmers Manufacturing Company. He was formerly assistant to the vice president in charge of tractor division. He joined Allis-Chalmers in 1934 as an industrial service man and demonstrator in the tractor division. In 1936 he was named assistant supervisor of the allied equipment department in the same division, and assistant to the executive vice president in charge of the tractor division in 1946. He was graduated from the University of Illinois.

William G. Hamilton, Jr. has been elected president of American Meter Company. Hamilton was first employed by Helme and McIlhenny, a subsidiary of the American Meter Company, after attending Swarthmore College. In 1932, he was made sales engineer in Philadelphia, specializing in refinery and chemical plant instruments.

W. G. Hamilton

He was appointed manager of the Philadelphia factory in 1946, and in 1947 became vice president in charge of sales, a position he has held until his recent election as president.

Theodore Ferguson was appointed district manager of the W-K-M Company's West Texas division. Under his supervision is **Clyde Cook,** who is moving his headquarters from Hobbs, New Mexico to Odessa, Texas. Ferguson is extremely well known throughout West and North Texas.

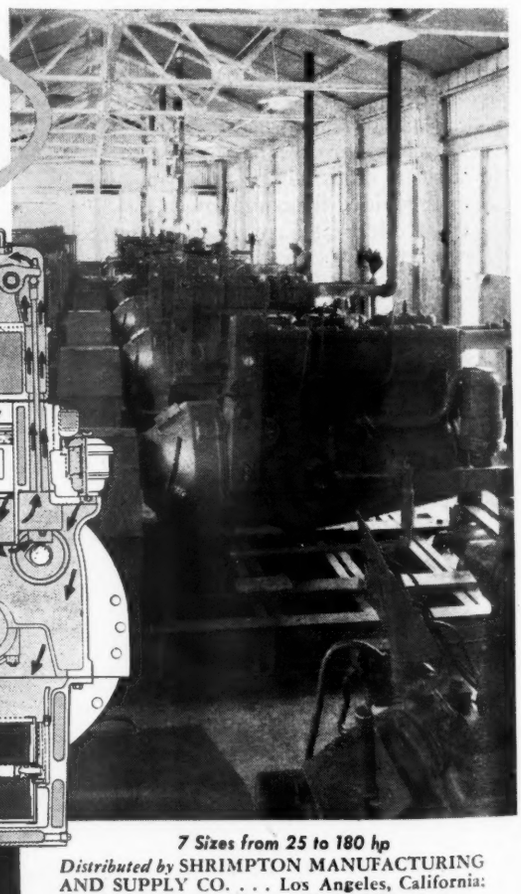
Theo. Ferguson

L. W. Matthey has been elected vice president and assistant general manager of Key Company, East St. Louis, Illinois. He was formerly assistant to the president. **F. B. Riggin** was elected vice president in charge of research development. Prior to his promotion, he was manager of manufacturing.

C. T. Hendrix has joined A. O. Smith Corporation as LP-gas carburetion sales specialist. Hendrix, formerly with Nash Motors Division of the Kelvinator Corporation, will work with dealers and distributors on carburetor conversion sales and will conduct LP-gas schools for dealer salesmen. He also will supervise the installation of A. O. Smith-marketed carburetors on large fleet accounts.

MINNEAPOLIS MOLINE
MM
MODERN MACHINERY

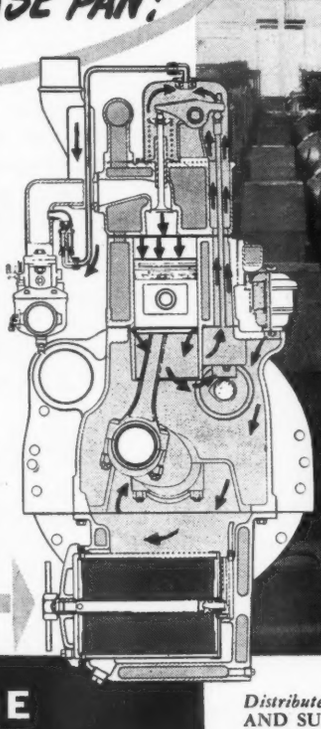
OILFIELD POWER
WITH HEAT EXCHANGER BASE PAN!



MM HEAT EXCHANGER BASE PAN maintains uniform operating temperature from top to bottom of the engine regardless of load or atmospheric temperature. This results in a sludge-free engine . . . best oil filtering . . . greatly extended periods between servicing . . . far fewer oil changes . . . and greatly prolonged engine life.

HERE'S HOW IT WORKS: The base pan is cast with water jackets just like the cylinder blocks and heads. A heavy-duty by-pass thermostat diverts the water from the outlet manifold through the base pan jacket and back through the pump and engine. Circulating the hot water around the oil in the pan eliminates outside radiation and maintains 165-180° temperature for ideal lubrication and filtering.

Positive Vacuum Crankcase Ventilation draws 2 to 3 cu. ft. of fresh air per minute through a metering valve. After mixing with oil-contaminating gases, raw and burned, it is withdrawn through the cylinder head covers and into the intake manifold. Investigate MM Oil Field Power . . . the engine with lower field service cost.



MINNEAPOLIS-MOLINE
MINNEAPOLIS 1, MINNESOTA

7 Sizes from 25 to 180 hp
Distributed by SHRIMPTON MANUFACTURING AND SUPPLY CO. . . . Los Angeles, California; Oklahoma City, Oklahoma; Kilgore, Texas

N. W. Rowand C. K. Hubbard

Norman W. Rowand has been named general manager of the Pittsburgh, Pennsylvania plant's meter and valve division, for Rockwell Manufacturing Company. He was formerly chief industrial engineer for the Pittsburgh-DuBois division. **C. K. Hubbard** has been elected a vice president of Rockwell Manufacturing Company. He will head the national accounts division. A graduate of Yale University, Hubbard joined Rockwell in 1936.

Robert L. Merrick, former manager of engineering, Fluor Corporation, Ltd., has been appointed manager of engineering and construction. He is a graduate of the Armour Institute of Technology, Chicago. New appointments also went to **John Marshall** and **Frank G. Crawford.** Marshall becomes the manager of engineering, and Crawford assumes the duties of chief engineer-mechanical. Prior to his promotion, Marshall was chief engineer-mechanical for Fluor. Crawford was formerly associated with the Union Oil Company.

Seagren Noltein Hanners

John Seagren has been appointed chief engineer of The National Supply Company's engine division at Springfield, Ohio. **Harvey W. Hanners** and **George F. Noltein** were appointed chief research engineer and consulting engineer respectively. A native of Sweden, Seagren received a degree in mechanical enginering in 1920 from th Chalmers Technical University in Gothenberg. In 1925 he joined Fairbanks-Morse and Company in the U.S. and National Supply last year.

Noltein has been with National Supply since 1927 and served the company as chief engineer and director of research until receiving his most recent appointment. Hanners joined National Supply in 1941 as a development and research engineer and has since been assistant to the chief engineer and chief engineer.

Edwin H. Price has been appointed Pacific Coast district manager, Manning, Maxwell and Moore, Inc., succeeding **Newton P. Selover,** who becomes director of export planning. Price, a graduate of the U. S. Naval Academy and Columbia University, joined the company in 1930. His headquarters will be in Los Angeles, Cal.

Warren Carhart has been promoted to supervisor of application engineering at the Lynwood plant of Western Gear Works. Carhart has been with Western Gear Works for the past 5 years and is an engineering graduate of Syracuse University. Western Gear Works operates a second plant in Seattle and recently announced plans to build a third plant at Belmont, California.

Warren Carhart

Glenn A. Dow, sales engineer for Mid-Continent Supply Company at Tulsa, Oklahoma, has been promoted to the position of division machinery manager at that city. Dow was first employed by Mid-Continent in 1947. In May 1948 he was promoted to sales engineer and assigned to the division office at Tulsa. He is a graduate of Texas University.

Roy H. Langford has been appointed sales engineer, Tulsa division, for Mid-Continent Supply. He began his oil career in 1933 working in the fields. He left the fields in 1935 to go into the supply end of the business and from that date on has been connected with supply firms in various capacities, mostly in the city of Tulsa.

R. W. "Ace" Elliott has been named Mid-Continent and Gulf Coast representative for Willis Oil Tool Company of Long Beach, California. He will replace Don F. Glover, who has been transferred to the home office at Long Beach. The Company manufactures the Willis Rotary choke for flowing wells, tubing and rod rotors for pumping wells. Elliott will make his headquarters in Houston.

R. W. Elliott

Frank L. Johnson has been appointed manager of export sales of The National Supply Company's engine division. Johnson graduated from the California Maritime Academy in 1938 with a BS degree in Naval Science. Upon graduation, he was employed with the Coast and Geodetic Survey for a period of 6 months until joining the American President Lines, where he worked in the operations department.

F. L. Johnson

Bruce V. Walch has been named manager of the field service department of the Four Wheel Drive Auto Company. He was formerly manager of the FWD parts sales department. Walch has been with FWD since 1927. He attended Wisconsin State Teachers College and Columbia University.

Frank Prosser, Emsco Derrick and Equipment Company, has retired after 28 years with the company. Prosser joined the D+B division of the company in 1936 at San Antonio, Texas, as manager of the South Texas district. In January, 1943, he was appointed assistant sales manager of the D+B division with headquarters in Dallas. A year later he was advanced to sales manager and in January, 1946, to Mid-Continent manager. At the time Frank joined the D+B organization he had had 13½ years' experience with the Shell Oil Company, and 7 years with the Santa Fe railroad.

Rodney G. Freeman has been appointed district sales engineer for Louisiana, Arkansas, Mississippi, and Alabama territory of the Cardwell Manufacturing Company, Wichita, Kansas. "Rod" is a native of Mississippi and since graduation from Mississippi State as a mechanical engineer, has been selling drilling and servicing equipment on the Gulf Coast.

R. G. Freeman

Garner L. Davis has been appointed district manager of the Mack Motor Truck Corporation's Houston Texas branch, announces A. F. Fenner, vice president and sales manager. During his five years with the Mack Company Davis has been a salesman at the company's Houston branch and district manager of the Oklahoma City and Dallas branches.

It's a Tough Job - on paper!

VISCO 24-Hour Field Service is a tough job—on paper. Visco men are actually on call 24 hours a day to handle any oil field or refinery emergencies . . . *but,* we have found that where Visco Emulsion-Breakers are on the job, treating difficulties are so rare that Visco Field Service Men can almost always plan on a good night's sleep.

If your treating has been an all-hours headache, better switch to the blue Visco barrels . . . no knockout drops in them, but efficient, economical emulsion-breaker performance around the clock, year after year. Call Houston, CAPITOL 7300, collect, for Visco action, *now!*

VISCO PRODUCTS COMPANY
INCORPORATED
City National Bank Building • Houston 2, Texas

Visco... **CONSISTENTLY EFFICIENT DEHYDRATING AND DESALTING CHEMICALS**

NOTICE: Visco Products Company is authorized to manufacture and sell Visco Oil Treating Compounds for use in the breaking and resolving of oil emulsions, or to grant licenses for such use, under the following United States Letters Patent: 2,050,639; 2,050,640; 2,206,589; 2,214,783; 2,214,784; 2,225,189; 2,303,414; 2,307,813; 2,318,034; 2,318,035; 2,321,056; 2,335,554; 2,454,808; 2,514,399. Visco Products Company is willing to grant licenses on a royalty basis, to oil companies, and to others desiring to practice the patented subject matter, under any and all of the above Letters Patent, permitting the user to purchase the oil treating compounds at will from any vendor, or to prepare the compounds for use or to use the compounds under the above Letters Patent. Application for license should be made to: **Visco Products Company,** Houston, Texas.

To obtain more information on products advertised see page E-33

New Machinery and Supplies

Use reply card to procure promptly complete information and prices of products described here in brief.

Circle corresponding letter or letters on reply card.

A—WATER COOLERS

Young Radiator Company has announced a new line of engine jacket water coolers. Gas and/or lube oil cooling coils may be mounted between the fan and liquid cooling core. the blower-type fan cools the oil and/or gas cooling coils first, with a minimum rise in air temperature, little affecting the cooling properties of the air flow over the liquid cooling core. This core arrangement is said to require a lower fan-horsepower requirement. Young Radiator Company.

Circle Letter A on reply card.

B—FLOW REGULATORS

Waterman Engineering Company announces the development of an adjustable flow regulator for cylinder speed control. This adjustable regulator gives a constant rate of flow regardless of pressure fluctuations or change in work resistance at any setting within the adjustable range. Adjustable range is 50 per cent of the calibrated flow rate in GPM. Waterman Engineering Company.

Circle letter B on reply card.

C—LAMINATED PANELS

Kaylo laminated panels, prefabricated sections for curtain walls and interior partitions, are now made in 9 and 10 ft lengths, in addition to 8. All panels are 4 feet wide and nominally 2 in. thick. Of "sandwich" construction, with a solid, incombustible core of Kaylo calcium silicate and then facings of cement-asbestos board, they insulate better than 16 in. of concrete. Owens-Illinois Glass Company.

Circle letter C on reply card.

D—STEEL HOIST

A new hoist designed for steel erection has been announced by American Hoist and Derrick Company. This new hoist incorporates features specified by steel erectors and hoist engineers from the industry. Through a torque converter, anti-friction bearings, and air operated, contracting type tandem band clutches, this hoist permits an operator to "feel" his load into position accurately and smoothly. Brake linkage between foot pedals and contracting bands is anti-friction bearing mounted for easy operation. Safety features include a back-up brake that engages automatically on reversal of the drive shaft, ratchet rings of forged steel with compression type dogs, and overload regulating air valves.

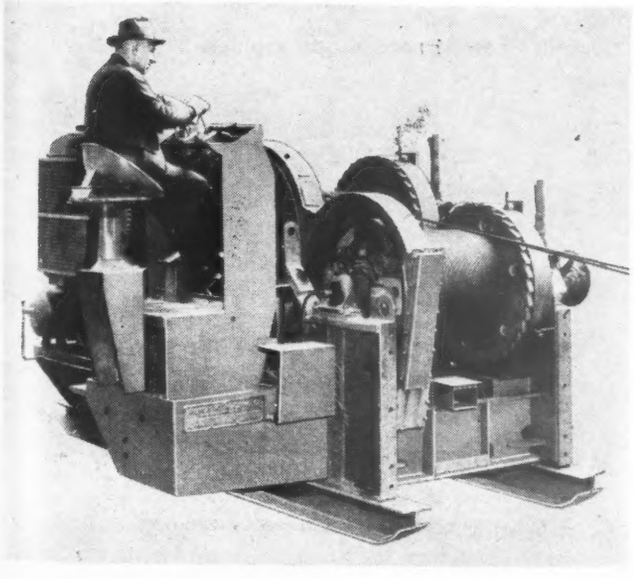
Circle letter D on reply card.

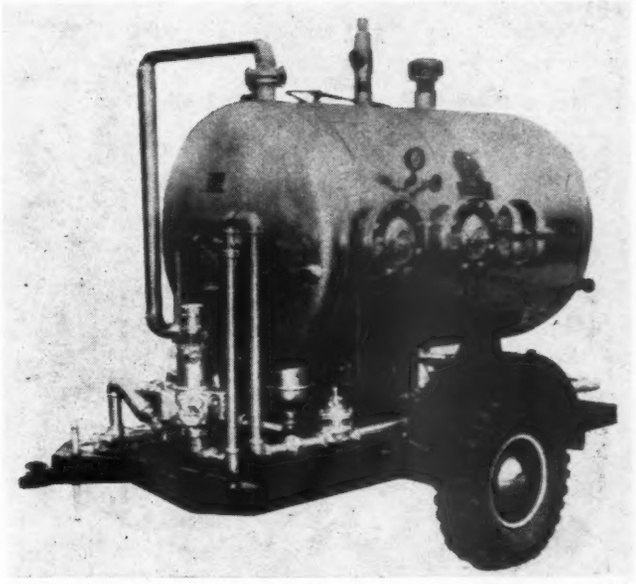
E—WELLCHECKER

The newly-developed Rolo wellchecker, Type No. 1H-4806, is a compact, portable well-testing unit with a 48 in. OD by 6 ft S. to S. by 150 psi WP horizontal oil and gas separator. It is completely piped with orifice fitting and diaphragm type back pressure valve. This well checker also has an automatic free water knockout feature, by means of which free water is segregated in the water compartment of the separator, its level controlled by a weighted float, and water is metered by water meter when discharged from the separator. Additional oil meters may be supplied manifolded in parallel to enable the unit to handle high rates of oil flow. Rolo Manufacturing Company.

Circle letter E on reply card.

New hoist designed by American Hoist and Derrick.





Portable well testing unit developed by Rolo.

F—LUBRICATING EQUIPMENT

Graco's field lubricators, redesigned for faster lubrication at the job site, have just been released by Gray Company, Inc. Featuring new Powerflo pumps, which easily handle the heaviest greases, these lubricators can be quickly mounted on truck or trailer. Graco convoy lubers are designed in two general classifications: (1) ready-to-work, completely assembled units, and (2) "job-planned" units, selected and assembled by the contractor to meet his particular greasing needs. Gray Company, Inc.

Circle letter F on reply card.

G—OSCILLATOR

A new, low frequency oscillator Model 410-A has recently been announced by the Krohn-Hite Instrument Company. It combines the sub-audio with the normal audio frequencies and provides both sine and square wave outputs over the entire frequency range from 0.02 to 20,000 cps. Six frequency bands are provided, each covering a full decade, with continuous control of frequency. A single, 11 in., illuminated, direct reading logarithmic scale is used on all bands. Krohn-Hite Instrument.

Circle letter G on reply card.

H—CHEMICAL FEEDER

A new Model 2-47CF Constaflo chemical feeder is announced. This new positive displacement, duplex diaphragm pump is equipped with two "See-Thru" plastic reagent heads and is driven by a ¼ hp motor. Its recommended delivery range is from 1.0 to 15 gal per hour. The Constaflo will draw solutions or slurries from a container and force them into a line or vessel under pressures up to and including 100 psig. %Proportioners, Inc.%.

Circle Letter H on reply card.

I—TURNING ROLL

The Worthington model 75PR turning roll was recently announced. Rubber wheeled, it has turning capacity of 75 tons, the carrying capacity of which is distributed among three units —one power roll, and two idler rolls, each having a 25-ton capacity. With steel rollers, its turning capacity is increased to 150 tons, and the carrying capacity is distributed among 6 units, one power roll and 5 idler rolls, each with a capacity of 25 tons. Worthington Pump and Machinery Corp.

Circle letter I on reply card.

J—TUBE PACKAGING

A new method of packaging U-bend tubes for head exchangers and condensers has been developed by Wolverine tube division of Calumet and Hecla Consolidated Copper Company, Inc. The new packaging permits direct installation from shipping pallet-to-condenser on receipt in the customers plant. Heretofore, U-tubes with different bending radii were shipped in separate packages. U-tubes will now be nested according to customer prints, and palletized at Wolverine plants. Condenser tubes may be moved directly from the shipping pallet into heat exchanger or condenser. Calumet and Hecla.

Circle letter J on reply card.

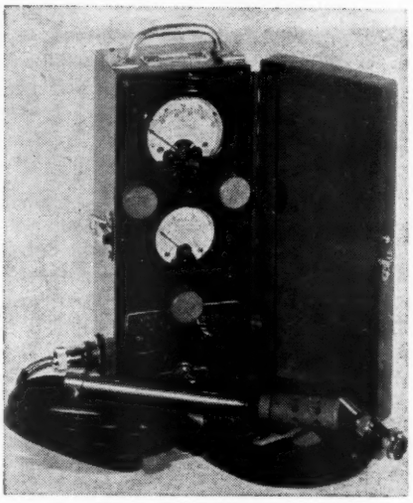
K—GAS ENGINE

Natural gas where available can be utilized in a new engine developed by Cummins Engine Company. Designed primarily to take advantage of the plentiful supply of natural gas in the oil producing areas, the new engine is known as the Model LR-600-GAS Cummins engine. The engine is classified in the medium speed field, because of its 1100 rpm rating. Now in production, the LR-600-GAS engine will be used principally to provide power for oil well drilling rigs. It is a 6-cylinder, spark ignition engine, with a displacement of 2477 cu in., a bore and stroke of 7¼ by 10, and a maximum rated horsepower of 315 hp. Cummins Engine Company.

Circle letter K on reply card.

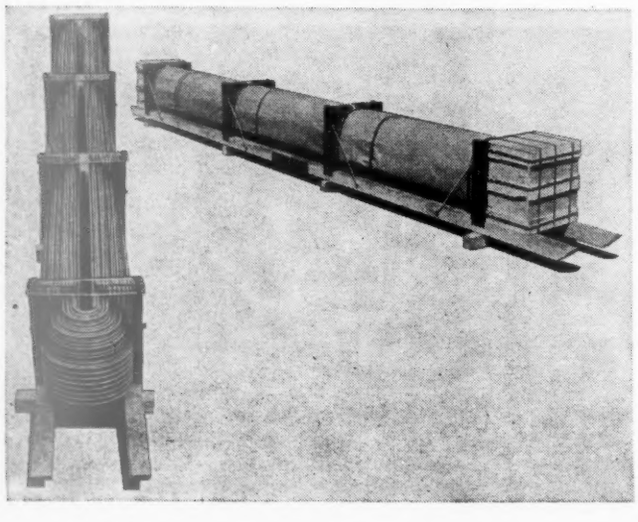
L—GAS INDICATOR

A new type portable gas indicator for detecting and measuring the hydrocarbons in drilling wells has been placed on the market. Designed for the geologist in the field, for use in drill stem tests, and drilling fluid sampling, the instrument weighs only 5 lb and measures 10 by 4 by 3 in. Traces of hydrocarbons are accurately, and quickly measured. It may be operated either from the car battery or any 6-volt source. The detecting element is contained within an external probe head attached by 6 ft electrical cord to the instrument case. Atlas Exploration Company.

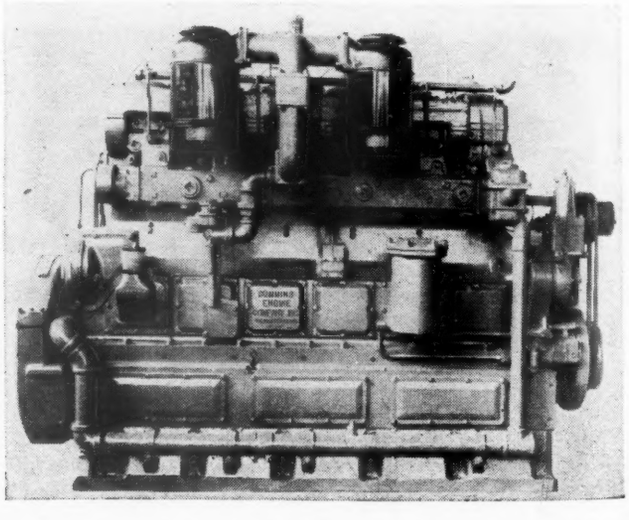


Circle letter L on reply card.

Calumet and Hecla's new packaging method.

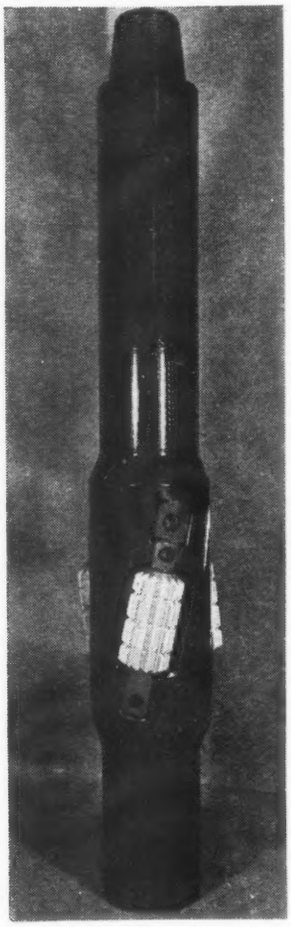


Cummin's newest natural gas engines.



M—HOLE REAMER

The Grant reamer, a tool that incorporates the minimum of parts and is designed for easy operation in stabilization and reaming out the hole to full gage, was recently put on the market. The tool is streamlined to



permit uninterrupted flow of circulation fluid, and the cutters are so angled that weight must be applied to make the tool progress downwards. It cannot, therefore, corkscrew itself into the hole. It can be run with either end up. Grant Oil Tool Company.

Circle Letter M on reply card.

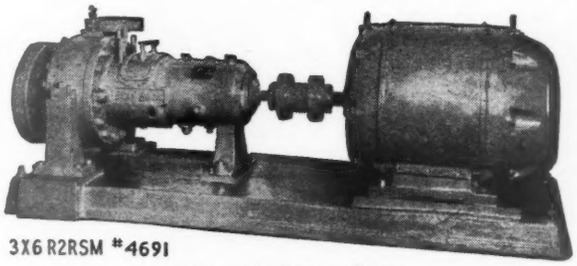
N—BREATHER VENT

Universal Controls Corporation has developed a breather vent for gas service regulators. A hood, or "umbrella" shields the vent opening from rain, sleet, snow, and ice. Other features are a thin-edged lower hood-rim, which sheds water, rather than encouraging it to gather to freeze, and a protected opening scientifically sized to keep out insects while permitting free and unrestricted flow of air or gas. Four different models are being produced, so that the Universal advantages may be incorporated on all standard regulator installations. Universal Controls Corporation.

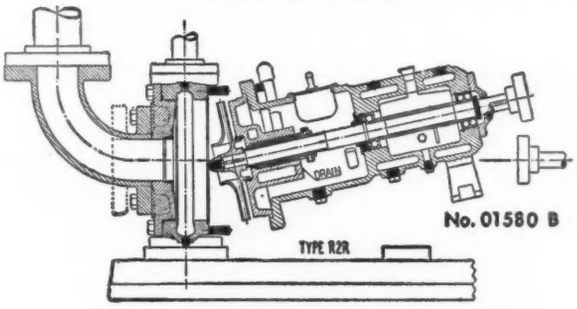
Circle letter N on reply card.

DEAN BROTHERS PUMPS INC.

Type R2R Centrifugal Process Pumps



Type R2R Process Pump



Type R2R Process Pump

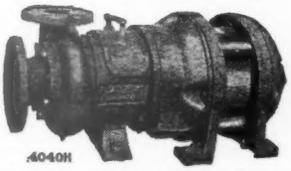
DISASSEMBLY: The Type R2R process pumps can be disassembled without disconnecting the suction and discharge piping. By first removing the spacer from the spacer type coupling, and unbolting the casing from the cradle the entire cradle and complete rotating element can be removed without disturbing the suction and discharge piping.

OPERATING RANGE: Type R2R, Heavy duty, process pumps are available in eighteen different sizes, enabling our engineers to furnish units specially designed and constructed for the particular work to be performed.

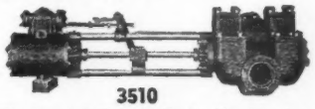
Capacities: 50 to 2000 Gallons per minute. Heads: Up to 400'. Speeds: 900 RPM to 4000 RPM.

BUILDERS OF OUTSTANDING PUMPS SINCE 1869

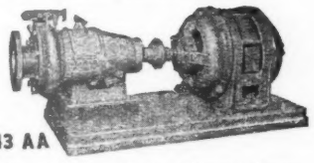
CENTRIFUGAL and RECIPROCATING PUMPS



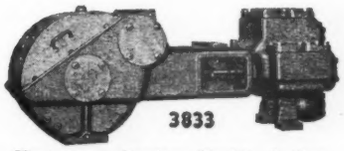
Close Coupled Centrifugal Pump



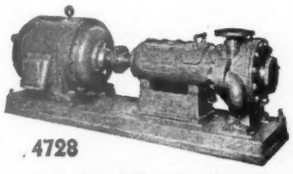
Horizontal, Single Style, Double Acting, Piston Type, Close Clearance Pump. Designed to handle volatile liquids



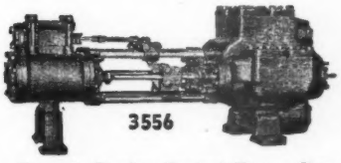
Pedestal Mounted Centrifugal Pump



Horizontal, Duplex, Double Acting, Side Pot, Piston Type, Oil Bath Power Pump



Double Pedestal Bearing Centrifugal Pump



Durable Duplex Packed Piston Pattern Steam Pump, Side Pot Type

ESTABLISHED 1869

DEAN BROTHERS PUMPS INC.

INDIANAPOLIS IND.

323 W TENTH ST.

Branch Offices: NEW YORK, N. Y., HOUSTON, TEXAS

Representatives in Principal Cities

To obtain more information on products advertised see page E-33

Sensational Performance

and unbeatable safety records!

In Two Great New U. S. RUBBER Rotary Hose

U. S. ROYAL 4—first rotary hose ever to offer these great advantages—

Double Reinforcing Wire Units—Royal 4 incorporates 2 double wire layers (4 stress wires in all) to a unit—each layer a hose in itself with sufficient hydrostatic value to resist bursting.

Highest Working Pressure—rules out the "burst" risk taken when conventional hose operates on the modern high-pressure pumps of today . . . eliminates costly switching to steel hose when high pump pressures are required.

Ultra-Flexibility—subjected to torturous factory "sling" tests, Royal 4—due to its special wire-reinforced, fabric-and-rubber construction—has demonstrated a degree of flexibility unparalleled in rotary hose history.

Complete Kink Resistance—with extreme flexibility from leakproof coupling to leakproof coupling, Royal 4 resists all forms of kinking even on mast type rigs.

Record Trouble-Free Test Performances—after two long and rigorous test years in the deepest fields of Texas, Louisiana and Oklahoma...under the highest pressures of off-shore-Gulf Coast drilling...U. S. Royal 4—in varying service lengths fitted to every type of rig—has come through without a failure.

U. S. MATCHLESS CABLE-LAY—new and vastly improved with qualities no other Cable-Reinforcing hose possesses—

Twist-Free Cable Construction—its 19-strand cable wire of highest tensile steel is so arranged as to completely eliminate the characteristic twisting of cable wire under stress.

Unique Failure-Proof Carcass—a special, soft, pliable yet super-strong cotton fabric overcomes the incidence of carcass failure so frequent in most flexible hose.

Complete Kink Resistance—Like U. S. Royal 4, ultra-flexible U. S. Matchless Cable-Lay with its built-in, leakproof couplings makes for a super-effective kink-resistant working length.

Extended Flex Life—with its special long-lasting carcass and twist-free cable strands in rubber-cushioned plies, U.S. Matchless Cable-Lay guarantees an appreciably longer flex life.

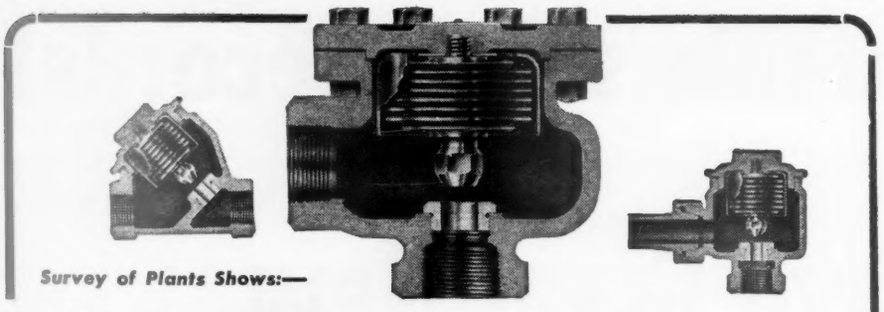
Product of Exhaustive Experimentation—thousands of tests involving wire sizes, strand numbers and degrees of flexibility preceded the making of U. S. Matchless Cable-Lay. Now—in answer to oilmen's demands for a better Cable-Reinforced hose—it is ready to add miles of drilled footage to service life.

Expert advice and service on the job are yours for the asking. See your "U. S." Distributor about these great new hose or write...

PRODUCTS OF U.S.RUBBER SERVING THROUGH SCIENCE

UNITED STATES RUBBER COMPANY

MECHANICAL GOODS DIVISION • Rockefeller Center, New York 20, N. Y.

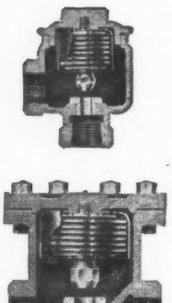


Survey of Plants Shows:—

15 of 20 Engineers Prefer Nicholson Traps

To determine the best steam trap on which to standardize, a large processing firm recently asked their plant engineers for their preference. In 15 out of 20 plants the choice was Nicholson.

The repeated adoption of Nicholson steam traps in plants currently in big "cost-reduction-through-modernization" programs is another indication of their advanced features. To learn why an increasing number of leading plants are standardizing on Nicholson thermostatic steam traps send for our catalog. 5 types for every power, heat, process use; size ¼" to 2"; press. to 225 lbs.



Bulletin 450 or see Sweet's

W. H. NICHOLSON & CO. 217 OREGON STREET WILKES - BARRE, PA.

STOP *Vapor Losses*

with OCECO "Type B" VENT UNITS

● Combined flame arrestor and conservation vent valve. These units protect both the tank and tank contents from entrance of flame; control and restrict tank breathing and prevent the free escape of vaporized liquids and lowering of gravity ratings. Sturdy, dependable, efficient and trouble-free Oceco construction. 2" to 10" sizes. *Write for Catalog 474-R. It gives full details.*

OCECO TANK FITTINGS

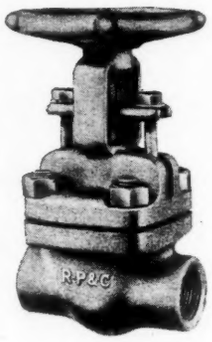
THE JOHNSTON & JENNINGS CO.

division of PETTIBONE MULLIKEN CORP.

4751 West Division St. • Chicago 51, Illinois

O—GATE VALVES

A forged steel gate valve has been designed by American Chain and Cable Company, Inc. Among its features are a bolted bonnet, which in-



sures maximum service life and low cost maintenance, tongue and groove joint with soft iron gasket to assure tightness under varying service conditions and extremely hard wedge facing that minimizes seizing, galling, and abrasive wear. Stainless steel gland bolts and nuts prevent freezing or corrosion. American Chain and Cable Company, Inc.

Circle letter O on reply card.

P—TRACK JACK

A new Simplex single-acting track jack, known as Model No. 16A has been introduced by Templeton and Company. The jack has features that speed up and simplify maintenance work on switches and spurs as well as general track work on refinery-maintained tracks. Among these are the very low minimum toe height of only 1½ in. This enables the jack to be placed under rail without removing ballast. The large forged toe, (2½ in. by 3¼ in.), stabilizes the load. Another advance in design is that trip can be operated from either the right or left side, with the operator protected in each case by an improved safety thumb guard. Templeton and Company.

Circle letter P on reply card.

Q—PULL TRACTOR

A new 12,000 lb drawbar pull tractor with torque converter designed to handle all tough pushing and pulling jobs is now being manufactured by The Buda Company. The new Buda model HA-120 shop mule tractor with a single stage, is powered with a 6 cylinder, 230 cu in. displacement Buda model 6-B-230 gasoline engine. As optional equipment this tractor is available with a Buda model 6-BD-230 diesel engine of the same large displacement and interchangeable mounting dimensions. Buda Company.

Circle letter Q on reply card.

R—PRESSURE INDICATORS

Two new maximum pressure indicators, one for cylinder firing and compression pressures and the other for oil fuel pump pressures have been put on the American market by Dobbie McInnes, Ltd., Glasgow, Scotland. The cylinder pressure indicator measures the compression pressures or the maximum firing pressures in the cylinder of an engine while operating. It can be used on all engines of all speed ranges. The fuel line pressure indicator provides a method of checking the fuel pump pressures on diesel engines and is particularly useful on those utilizing high viscosity oil fuels, by warning of choking atomizers that may produce undesirable fuel line pressure 100 per cent or more above normal. Dobbie McInnes, Ltd.

Circle letter R on reply card.

S—RECEIVER RECODER

George Kent, Ltd. has produced a multi-point air-operated receiver recorder which provides a synchronized side-by-side record of the principal measured or controlled variables in a system. It can be used in conjunction with a transmitter mounted in any of the standard Kent instruments or others providing they emit the required pressure range. The receiver records on a chart divided into three distinct zones and operate on 3, 4, 5, or 6 points. When it is operating on more than 3 points, and two pens are recording on one zone, different colored inks are used. Net weight of the instrument is 70 lb. George Kent, Ltd.

Circle letter S on reply card.

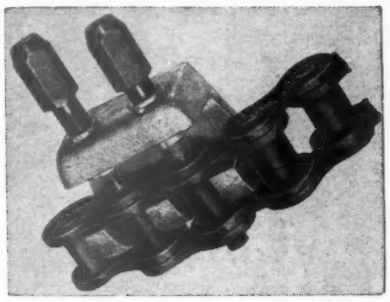
T—SWINGING FINAL DRIVE

A swinging final drive has been added to the swinging compounds developed by Mid-Continent Supply Company. The swinging final drive shortens rigging up operations. It eliminates the problem of aligning sprockets and connecting the chain between the compound and the input of the drawworks. With the swinging final drive and swinging compounds the only chain broken is the rotary chain. Designed for use with the Mid-Continent multiple engine rig drive, the swinging final drive is completely enclosed in an oil tight, dustproof case, assuring long chain life. Lubrication is accomplished through spraying a stream of oil directly on the sprockets of the swinging final drive. Oil is pumped into the channel reservoir, sprayed on the sprockets, and drains to the lowest part of case where it is picked up by the pump. Mid-Continent Supply.

Circle letter T on reply card.

U—CHAIN REPAIR TOOL

S. R. Bowen Company recently placed on the market the Bowen Punch-Out chain repair tool, which is designed for use in dismantling or re-

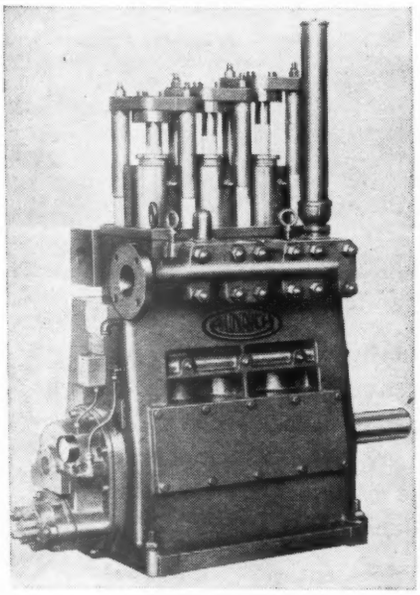


pairing roller chains. According to the manufacturer, this tool positively eliminates the danger of steel splinters injuring workmen; cuts down repair and dismantling time, and prevents damage to chain that results from sledging. The Bowen repair tool is available for A.S.A. roller chains in normal pitch from ½-in. to 3-in. sizes and for API Roller Chains in 3-, 3⅛, and 4-in. sizes. S. R. Bowen Company.

Circle letter U on reply card.

V—TRIPLEX PUMP

The Aldrich Pump Company announces the addition of a 3 in. stroke triplex, direct flow pump to their over-all line. This triplex unit can operate at speeds up to 500 rpm—an



increase over previous models, resulting in more work from a lighter, more compact pump. Power ranges up to 50 hp; pressures up to 3300 psi, and displacement up to 96 gal/m (3275 bbl per day) at 790 psi, 500 rpm. The direct flow pump passes liquid in a straight line, directly through the working barrel.

Circle letter V on reply card.

STOP LABOR WASTE WITH Ledeen CYLINDERS

Wherever you have to—

PUSH or PULL

LIFT or LOWER

PRESS or SQUEEZE

TILT or TURN

OPEN or CLOSE

Ledeen cylinders provide positive, dependable power and pressure in straight line motion. Designed for air, oil, or water operation, they are uniform in design and construction, affording a wide number of varieties and adaptations. Ledeen cylinders are easy to install, occupy minimum space, and are built for long, economical service.

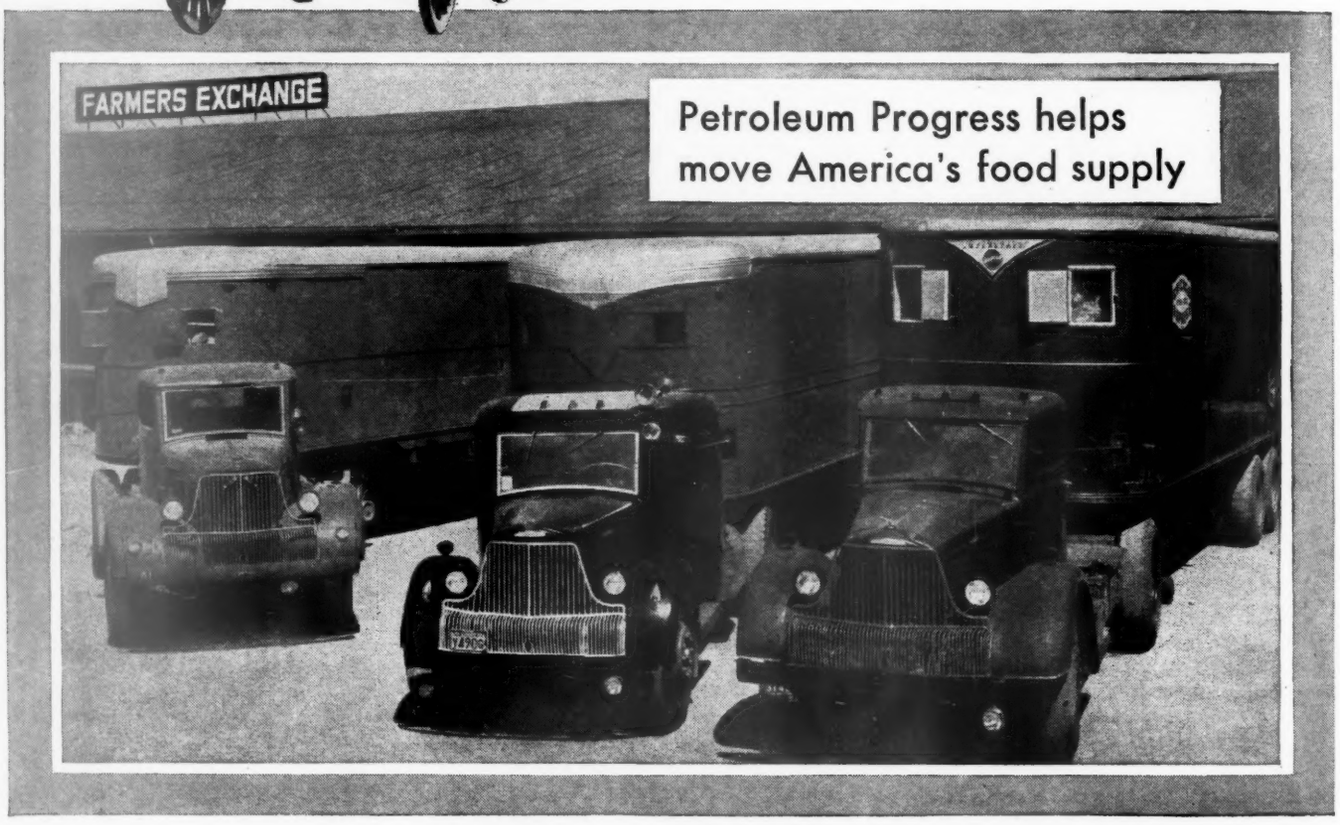
Standard Ledeen cylinders and mountings are available from distributors' stocks in major cities. Special cylinders if required. J.I.C., of course.

Ledeen Cylinders are GOOD Cylinders

Write for Bulletin 500

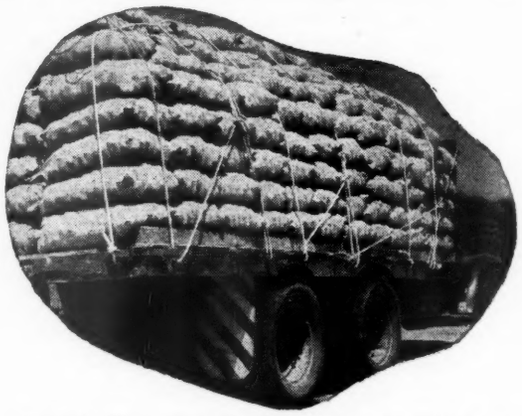
Ledeen Mfg. Co.
1608 San Pedro
Los Angeles 15, Cal.

Dobbin doesn't work here any more !



LONG AGO farmers raised food primarily for their families. Any surplus was "horsed" to local markets. Today the nation's tremendous farm output moves to market at high speed and on schedule. Produce and perishables are delivered garden-fresh. Gasoline and Diesel-powered trucks reach into every corner of the land, cover swiftly America's 3 million miles of roadways.

Here petroleum research and development work for the welfare of a nation and the world. And—here is another instance of free men at work in a land of free competition.



Close to 90 percent of all agricultural products marketed are shipped by truck. And almost half of this is hauled by farmer-owned and farmer-operated trucks — of which there are more than 2½ million today. Everywhere trucks travel, Texaco petroleum products are there, too, to insure efficient, economical operation and maintenance.

TEXACO
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THE TEXAS COMPANY

Petroleum Promotes Progress

To obtain more information on products advertised see page E-33

W—WALL CUTTER

A new, special purpose, thin wall external cutter has recently been announced by the McCullough Tool Company. The new cutter permits the external recovery of drill pipe, casing and tubing in tight holes. It is a special cutter, for use only where standard cutters cannot be used, due to extremely small clearances between the pipe and casing, or between joints and the wall of the drilled hole in an oil well. By special design of the cutting mechanism, a minimum wall thickness of $\frac{7}{16}$ of an inch is made possible. All operating parts of the cutting mechanism, including the knives, are contained in the wall of the cutter. No parts protrude inwardly or outwardly while going into the hole!—McCullough Tool Company.

Circle letter W on reply card.

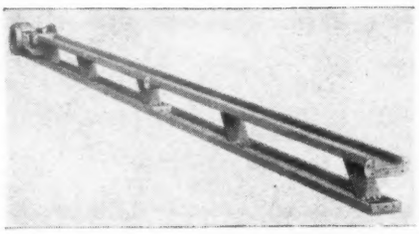
X—WELDED FITTINGS

Welded fittings and joint for corrosion resistant coated piping are announced by Welstrom. Welstrom fittings and joints are available in all standard sizes and types of welding fittings and joints from ½ in. up to 30 in. in diameter. They are coated or lined with corrosion resistant coatings in the manufacturer's plant. Any alterations that are necessary for field assembly resulting from slight changes in design layouts, can be made in the field. A typical fitting has three parts, an internal sleeve and two external fittings. Welstrom.

Circle letter X on reply card.

Y—TROUGH CONVEYOR

A new conveyor of oscillating trough type, called Link-Belt Flexmount, has been developed for handling a great variety of loose bulk materials at moderate capacities. The Flexmount design features the use of



a one-piece metal trough with high sides, supported on one-piece flexible members, which function as springs in absorbing the energy of the trough movement at each end of the stroke. Conveyor trough is normally 4 in. deep and come in standard widths of 8 to 24 in., made of No. 10 or 12 gage steel, stainless or corrosion resisting steel, or other special material. Link-Belt Company.

Circle letter Y on reply card.

Z—ROLLER CHAIN PINS

Baldwin-Duckworth Division of Chain Belt Company claims that as a result of their present method of copper-plating roller chain pins, optimum hardness for the pins is assured. Other claims are: Copper plating assures uniformly good riveting, greatest holding power of pins, and easy chain cutting. After cutting, tapering, and rough grinding of the pin ends, the pins are entirely copper plated in a copper solution bath. In the case hardening operation, only the body of the pin absorbs carbon. Pin ends are comparatively soft. The copper pin end is riveted to the side plate . . . the softened end makes for a firmer, stronger rivet. Chain Belt Company.

Circle letter Z on reply card.

AA—SCRATCHER

A new hinged construction has been provided in the B and W Nu-Coil Scratcher. A heavier base and window type hinge are combined with a high tensile spring curved pin. This scratcher is of the latch-on type and is adapted to installation on external upset casing or on casing joints on which the welded scratcher stop lugs are placed in the casing storage yard or on the dock before moving to a marine location. B and W Inc.

Circle letter AA on reply card.

Get the Sludge out of your Diesels!

SLUDGE in lubricating systems increases wear, reduces normal engine life. To get rid of it fast, just circulate a solution of Oakite Composition No. 7, emulsion type solvent cleaner. Saves time, money, engines.

Ask your local Oakite Technical Service Representative for free on-the-spot demonstration. Or write Oakite Products, Inc., 48 Thames St., New York 6, N. Y.

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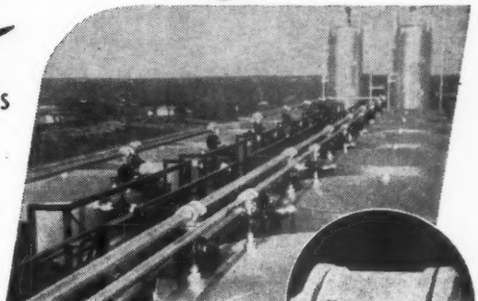
VAPOR CONTROL

CLOCK SWITCHES



SLIP-ON FITTINGS

By eliminating threads and grooves Enardo Slip-On Fittings slice 2/3 off line-connecting time. The flexibility of these performance-engineered fittings assures leak-proof connections even on misaligned joints. No expansion joints required. Available in all styles and four sizes, 2 to 6 inches, for working pressures up to 125 lbs. Perfect for lease work because of their full salvage value. For Canadian delivery write National Tank Co., Ltd., Box 4184, Edmonton Station, Alberta, Can.

ENARDO

BOX 1647
TULSA, OKLA.

AB—CAGES

John N. Martin has announced development of CAGES equipped with synthetic rubber ball guides (perforated to prevent blisters), which are held in place by both mechanical means and oil proof cement. The well known properties of rubber, such as resilience (against beating of the ball), resistance to sand abrasion, non-magnetic character, and electrical resistance, are thus employed to combat the cage problems. John N. Martin.

Top Cage — Synthetic Rubber Ball Guides — Lower Cage

AC—ULTRA-VIOLET LAMP

A new line of Blak-Ray high-intensity long-wave ultra-violet lamps for observing fluorescence is announced by Ultra-Violet Products. These lamps were originally designed for defense purposes but have important applications for laboratory analysis and industrial inspection because of their improved u.v. output.

Blak-Ray lamps are equipped with a self-filtering "black-light-blue" tube that allows the long-wave ultra-violet rays (3660 angstrom units) to pass through but filters out the undesirable rays in the visible portion of the spectrum. No additional filters are required and the cool-operating tubes will last for 2000 to 3000 hours. Recommended for use at low light-levels, they do not, according to the manufacturer, require as great a degree of darkness as lamps using separate filters. Ultra-Violet Products, Inc.

Circle letter AF on reply card.

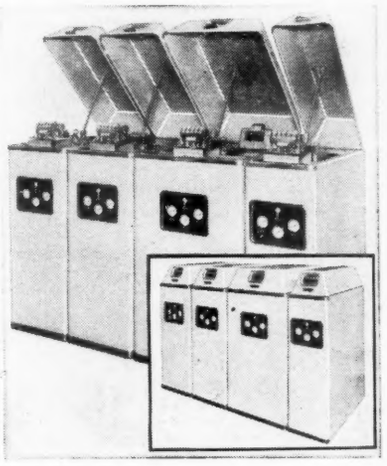
AD—ASPHALTIC COVERING

A new asphaltic coating, Dica-Rode, is now available from The Zone Company, a division of Southwestern Petroleum Company, Inc. Dica-Rode is manufactured in two forms, one form using Canadian asbestos to give the coating greater tensile strength and body, the other without asbestos fiber. Premium asphalts are used in both forms. The coating without asbestos fiber is suitable for use on underground portions of concrete or steel foundations. Fibered Dica-Rode is preferable for use on pipe lines. One gallon of Dica-Rode will insulate about 100 sq ft of new pipe surface. The Zone Company.

Circle letter AD on reply card.

AE—LIQUID BLENDER

A new automatic proportioning system for blending two or more of a wide variety of liquids has been developed by Bowser, Inc. No charts or calculations are used to set the blender for any combination of liquids. Simple



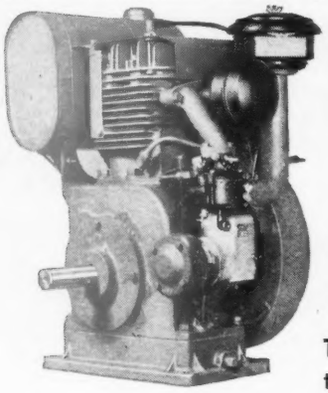
controls on each meter permit instantaneous setting of ingredient proportions in increments. Total throughput is recorded on a master counter and each ingredient is recorded separately on its own meter.—Bowser, Inc.

Circle letter AE on reply card.

AF—LOCK COVER

A lock on the cover of the TAG non-indicating controller for temperature-pressure, for "locking in" control point settings, is announced by the TAGliabue Instruments Division of Weston Electrical Instrument Corporation. As a new feature added to the controller, the locking device eliminates the danger of unauthorized persons willfully or accidently changing control point settings. In the new design the control setting mechanism is a spindle with a slotted tip placed entirely behind the locked cover of the case. Weston Electrical Instrument Company.

Circle letter AC on reply card.



Four Single-Cylinder WISCONSIN *Air-Cooled* ENGINES Offering More POWER ADVANTAGE, 6 to 9 hp.

This series of single-cylinder models have all of the traditional Wisconsin heavy-duty features such as self-cleaning tapered roller bearings at both ends of the crankshaft, rotary-type, high tension OUTSIDE magneto operating as an independent unit, and maximum torque at all usable speeds.

CONDENSED SPECIFICATIONS

MODELS	AEH	AFH	AGH	AHH
Bore - - - - - - - - - inches	3	3¼	3½	3⅝
Stroke - - - - - - - - - inches	3¼	4	4	4
Disp. cubic inches - - - - - - - - -	23	33.2	38.5	41.3
H. P. and R.P.M. range - - - - - - -	3.9 at 1600	6.0 at 1600	7.2 at 1600	7.7 at 1600
	6.1 at 2600	7.2 at 2200	8.4 at 2200	9.2 at 2200
Net weight in lbs., Standard Engine - - -	130	180	180	180

Our engineering department will gladly cooperate with you in adapting Wisconsin Engines to your requirements. Write for detailed data and name of the nearest Wisconsin distributor.

WISCONSIN MOTOR Corporation
MILWAUKEE 46, WISCONSIN
World's Largest Builders of Heavy-Duty Air-Cooled Engines

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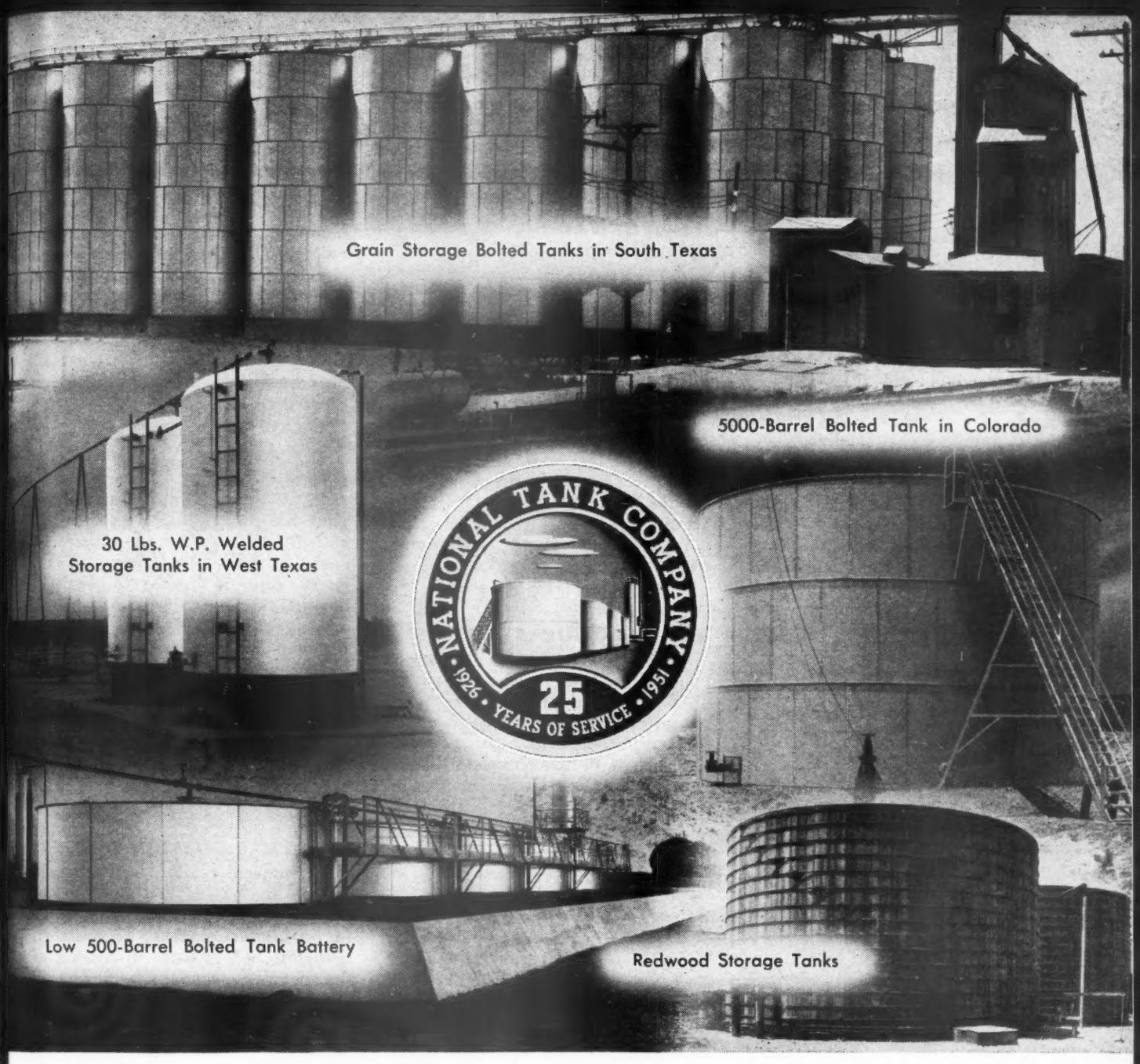
OIL FIELD DISTRIBUTORS FOR WISCONSIN ENGINES AND ALL TYPES OF UTILITY UNITS.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1926 • 25 YEARS OF SERVICE • 1951
Low 500-Barrel Bolted Tank Battery
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National Serves The Oil Industry EVERYWHERE!

National Tank Company has constantly expanded its facilities during the past 25 years to keep pace with the demands of an ever-growing, world-wide market for National's products. The development and production of many National "Firsts" are responsible for this growth.

Our highly-skilled research and engineering staff is constantly making new discoveries. They are designing and producing newer, bigger, faster equipment to bring to the petroleum, chemical and manufacturing industries increased production with more economy and greater safety.

National recently increased its plant capacity to seven acres under one roof—added many new plant facilities and equipment to assure that "It's a National" means the finest!

It's a National

NATIONAL TANK COMPANY

TULSA, OKLAHOMA

Trade Literature

Publications will be sent free.

AG—STREAMLINED SWIVELS

IDECO announces that Bulletin SS-51 is now available. This new booklet describes the Model DSS-300, SS-300, SS-250, and SS-150 streamlined swivels with floating washpipe assemblies. The bulletin presents construction details, specifications, and one page of photos showing the "Nonpareil" washpipe packing quick change procedure. Also available is a new condensed catalog covering all IDECO equipment. This new catalog is complete with photos, descriptions, and specifications on the entire IDECO line of drilling, servicing, and general oil field equipment. This 71 page bulletin is known as Condensed Catalog 51. Dresser Equipment Company.

Circle letter AG on reply card.

AH—CLEANING PIPE

The Flexible Pipe Cleaning Company has published a folder on its various tools used in cleaning pipe. Latest machine in the Flexible line is a "RODucteR" developed for the specific purpose of mechanically rodding phone and electric ducts. The RODucteR now brings duct rodding techniques in step with other developments in the maintenance of communications installations. Other features are the diagrammatic illustration of the "Flexible" power drive rodding that may be used in various diameters of lines with only one trench needed, and the chain head auger, which is used for cleaning of small diameter lines. Flexible Pipe Cleaning Company.

Circle letter AH on reply card.

AI—BLOCK INSULATION

A new 4-page folder on superex block insulation was recently published by Johns-Manville. This high temperature insulation used by Johns-Manville is described in the bulletin, along with a list of the outstanding properties of this insulation. This information is backed up with conductivity and heat loss graphs, as well as a recommended thickness table. The back cover shows a few of the many special shapes in which superex can be supplied. Johns Manville.

Circle letter AI on reply card.

AJ—PRE-FABRICATED PIPING

Western Piping Supply Division of The Lummus Company has prepared a new bulletin entitled "Pre-Fabricated Piping." This two-color, illustrated booklet discusses advances made in the field of high and low pressure piping subassemblies. It describes and pictures pipe bends, coils, headers, manifolds, Vanstone work, process piping, and welded assemblies produced in the division's shops for the power generation, petroleum refining, pipe line transmission, paper, steel, chemical, and heavy industries. The Lummus Company.

Circle letter AJ on reply card.

AK—ELECTRICAL FITTINGS

A handy, compact, easy reference manual has been made available by O. Z. Electrical Manfacturing Company, Inc. The new manual contains illustrations, catalog number, price, and weight of the complete line of O.Z. electrical fittings. Distributors' countermen, electrical contractors, and estimators will find this handy manual extremely simple to use.

Circle letter AK on reply card.

AL—MOTOR GRADERS

A new 16-page booklet entitled "Quality at Work Through the Years with 'Cat' Motor Graders," has been published by International Harvester. The booklet features the history of research and engineering of testing and on-the-job experience, of manufacture and inspection behind the "Cat" motor grader. International Harvester.

Circle letter AL on reply card.

AM—CALCIUM SILICATE

Kaylo calcium silicate products and their various uses are described fully in a new 24-page booklet ready for distribution by the Kaylo division of Owens-Illinois Glass Company. The first half of the booklet is devoted to research and development history of hydrous calcium silicate product and a description of its properties. Profusely illustrated, the booklet outlines the various advantages of Kaylo laminated panels and firedoors. The incombustible panels serve as either exterior curtain walls or partition sections, and require no finishing, painting, or plastering. Owens-Illinois Glass Company.

Circle letter AM on reply card.

AN—PNEUMATIC STANDARDS

The JIC pneumatic standards for industrial equipment, recently adopted by the Joint Industry Conference on pneumatics, are now made available to the public by Miller Motor Company. The "Standards" are reproduced in full—with sample circuit, glossary of terms, 2 pages of standard symbols, and a comparison showing how Miller air cylinders meet the "Standards" point for point, all compiled in a hole-punched 12-page booklet for filing. Miller Motor Company.

Circle letter AN on reply card.

AO—DRYERS

C. M. Kemp Manufacturing Company has published a 2-color 4-page bulletin on its standard radiation—cooled dryers. Application of the Kemp dryer is limited to small or medium flow rates. It consists of dual adsorption towers with an externally mounted reactivation system. Each tower is charged with sufficient quantity of granular desiccant to continuously dry the volume of gas entering under the service conditions specified. C. M. Kemp Manufacturing Company.

Circle letter AO on reply card.

AP—TRANSMISSION DRIVES

A complete catalog is now available on the new Hy-Vo power transmission drives recently announced by Morse Chain Company. The catalog, includes: (1) A basic discussion of the operating principles behind chain drives; (2) highlights of design principles incorporated in Hy-Vo drives; (3) description of what the drive will do in high-speed, power transmission; (4) Hy-Vo capacities, speed ranges, and service factors, and (5) installation and lubrication procedures. Morse Chain Company.

Circle letter AP on reply card.

AQ—WATER TREATMENT

Brooks Chemicals, Inc., has published a 16-page booklet on water conditioning. The booklet gives considerable technical data and describes Brooks services, products, and methods employed in solving many water problems. Brooks water treatment service is divided into 7 categories: (1) boiler water; (2) water line; (3) cooling water system; (4) brine system; (5) waste water; (6) zeolite softener, and (7) consulting service. Included is a study of 10 impurities common in water, the damage they cause, and how to combat them. Brooks Chemicals, Inc.

Circle letter AQ on reply card.

AS—CRAWLER TRACTOR

A new International TD-9 diesel crawler tractor catalog has just been published by International Harvester Company. A two-color presentation, the catalog contains detailed specifications and information on how the TD-9 develops and applies its 40.5 drawbar horsepower. Several varied job application scenes appear in the publication along with information on construction and operating features. International Harvester.

Circle letter AS on reply card.

AT—CENTRIFUGAL PUMPS

The Chain Belt Company has just placed on the market a new line of self-priming centrifugal pumps. This new line ranges in size from the small 1½-in. Model 4M pump up to the 6-in Model 90M pump. Capacities of these sizes ranges from 4000 gal per hour up to 90,000 gal per hour. These pumps are guaranteed to meet the capacity standards adopted by the Contractors Pump Bureau of the Associated General Contractors of America. The new Rex pump is designed for easy and inexpensive replacement of wearing parts. Removal of the easy-to-get-at cover plate makes it possible to replace or adjust practically all the wearing parts in the pump. A new catalog is available, which further describes the pump in detail. Chain Belt Company.

Circle letter AT on reply card.

AU—RUBBER RESIN COATINGS

A discussion of the characteristics, properties, uses, and methods of application of synthetic rubber resin based coatings is contained in a new brochure just issued by the Casey and Case Coating Company. Covered are machinery enamels, damp-wall enamels, stucco-masonry coatings and scuff-free floor finishes, all primarily formulated for maximum resistance to corrosion or erosion. Casey and Case Coating Company.

Circle letter AU on reply card.

AV—CONTROLLER

Minneapolis-Honeywell Regulator Company has published a new 2-page sheet giving engineering specifications on the new Brown ElectroniK strip chart pneumatic control potentiometer. The new strip chart potentiometer controller has a proportional band and automatic reset dials, making possible full automatic operation. This type controller gives the further advantage of a full 11-in. calibrated chart width and over 120 ft of chart length. Minneapolis-Honeywell Regulator Company, Brown Instruments Division.

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To obtain more information on products advertised see page E-33

AW—POWER PLANTS

Bulletin Q-14 "Elliott Equipment for Power Plant and Industry," has just been released by Elliott Company. Liberally illustrated, this booklet reviews the complete Elliott line; describes briefly the major steam and electrical products of the five Elliott plants. Material is organized into sections, one covering steam and related equipment (turbines, centrifugal blowers, condensers, heaters, tube cleaners, etc.), the other devoted to rotating electrical equipment. Elliott Company.

Circle letter AW on reply card.

AX—TRACTOR EQUIPMENT

Trackson Company, manufacturer of tractor equipment for "Caterpillar" diesel tractors, has just published a new catalog, Form No. 1106, covering the complete line of Trackson tractor equipment. Products described and illustrated include the Traxcavators tractor-shovel teammates of "Caterpillar" diesel tractors. All five sizes of Traxcavators are shown. Other machines described include Trackson pipe layers, earth augers, TracLoaders, swing cranes, and land clearing equipment. Specifications are included for each unit. Trackson Company.

Circle letter AX on reply card.

AY—POWER VISUALIZER

A power factor visualizer presenting an explanation of the use of capacitors in solving low power factor problems is available from the Westinghouse Electric Corporation. Prepared in the form of a slide-rule-type chart, the visualizer makes it possible to follow a hypothetical case involving low power factor and shows how the installation of capacitors can solve this, as well as many similar problems. The chart explains what low power factor is, what it means to both user and supplier, and what benefits can be obtained by installing capacitors. Westinghouse Electric Corporation.

Circle letter AY on reply card.

AZ—STEEL FITTINGS

Tri-Clover Machine Company has published a new 16-page catalog, which describes their Schedule 5 and 10 IPS size stainless steel "Zephyrweld" fittings. This new line of stainless steel fittings will augment Tri-Clover's lines of "Zephyrweld" tube O.D. butt weld fittings, recessed end fittings, flanged conical end types, and sanitary fittings. Tri-Clover Machine Company.

Circle letter AZ on reply card.

BA—CELLULAR RUBBER

A revised and enlarged catalog, and a panel of actual samples of Rubatex closed cellular rubber, are now available. The catalog features a chart of the properties of Rubatex as improved to meet the recently revised ASTM Standards No. D-1056-49T. ASTM specification numbers are listed. Unlike sponge rubber, in which the cells are interconnected, Rubatex is composed of minute individually-sealed rubber-walled cells, which are filled with inert nitrogen under pressure. Rubatex is impervious to moisture (it cannot absorb fluids, even at cut edges). Rubatex Division, Great American Industries, Inc.

Circle letter BA on reply card.

BB—EXTENSION WIRES

Thermo Electric Company, Inc., has printed an 8½ by 5½ in. chart showing the applications, calibration symbols, conductors, polarity, and Thermo Electric, Instrument Society of America (I.S.A.), and military color codes of thermocouple and extension wires. Resistance tables for these wires are shown on the reverse side of the chart. Thermo Electric Company.

Circle letter BB on reply card.

BC—HOSE LINES

Aeroquip Corporation has published its latest industrial catalog, giving complete information about its industrial products. Also included is information on how to order Aeroquip parts and the construction and principles of its hose lines and detachable, reusable fittings. The catalog has a loose-leaf arrangement, which permits users to order additional catalogs consisting of selected pages. Aeroquip flexible hose lines can be assembled easily by using bulk hose and the particular fittings needed.

Circle letter BC on reply card.

BD—SURGE CONTROL

Through proper design and the use of snubbers, such costly innovations as special piping or specially reinforced pipe line structures in compressor installations become unnecessary, according to an industrial bulletin on "Surge Control in Gas and Air Piping," issued by the Burgess-Manning Company. This bulletin states that installation can be designed that will be free from surging and the resultant vibration of gas pumps. It also contends that metering fluid flow will be simplified in a properly designed system.

Circle letter BD on reply card.

BE—PIPE CORROSION

How to stop service pipe corrosion with tape is explained in a new 4-page brochure, published by Minnesota Mining and Manufacturing Company. The brochure tells how a single tape—"Scotch" brand electrical tape No. 22—can combat the corrosive action of moisture, alkalies, etc., on underground gas service pipes. Featured is the report of a gas company, which cites 6 advantages for the tape: (1) corrosion protection; (2) faster to apply; (3) good conformability with 125 per cent stretch; (4) elimination of hot coating methods; (5) easier spot repairing, and (6) improved public relations. Minnesota Mining and Manufacturing Company.

Circle letter BE on reply card.

BF—DRILLING RIG

A new bulletin, No. 375, which describes the Ideal Type T-20 drilling rig, a 200-hp rig for shallow drilling, medium depth servicing and workover jobs, is announced by The National Supply Company. The bulletin contains 8 illustrated pages featuring rig design and construction, operation and controls, and giving specifications, performance chart, dimensional drawings and drive arrangement diagram.

Cicle letter BF on reply card.

BG—HAND PUMP

A four-page bulletin describing its new high-vacuum hand pump has been published by Tokheim Oil Tank and Pump Company. The new type of diaphragm pump has a greater vacuum efficiency than ordinary diaphragm pumps and discharges a steady flow of liquid on both the forward and backward stroke. Its flexible diaphragm pumps without changing volume, making a positive displacement pump. All parts in contact with the liquid are of noncorrosive materials. Replacement and cleaning can be easily accomplished with screw driver and pliers. Tokheim Oil Tank and Pump Company.

Circle letter BG on reply card.

BH—COATED DIAPHRAGMS

A new illustrated brochure has just been released by Vulcan Rubber Products, Inc., detailing properties and designs of synthetic coated diaphragms for all types of gas meters. The company has also released a second folder describing molding diaphragms for use in all types of regulators, governors, and controls. Vulcan Rubber Products.

Circle letter BH on reply card.

BI—MUD GAUGE

Shand and Jurs Company has published a 2-color bulletin on its mud gage for use in the control of mud flow at a well. The S and J mud circulation indicator consists essentially of an automatic tank level gage and a return mud flapper valve. An indicating device keeps the driller aware of the mud circulating system on his rig. The same indicator can be put on floor of rig directly in front of the driller. The left hand dial indicates the rate of mud return coming from the well, and the right hand dail indicates the depth of mud in the pit. Shand and Jurs Company.

Circle letter BI on reply card.

BJ—CHART DRIVES

Rockwell chart drives and accessories for recording meters and instruments are described in a new bulletin just issued by the Rockwell Manufacturing Company. The 8-day chart drives come in two sizes, standard and midget, adapted to a variety of rotation speeds by turrets that quickly convert to any 10 additional speeds of from 2 hours to 8 days. The bulletin also describes 31-day drives with turrets to convert to speeds of from 15 to 31 day cycles. Rockwell Manufacturing Company.

Circle letter BJ on reply card.

BK—HEAT TRANSFER SURFACES

A new bulletin issued by Modine Manufacturing Company illustrates a wide variety of specialized heat transfer surfaces, which the company has developed for industrial products and processes. Surfaces shown are applicable to such equipment as solvent recovery, intercooling, regeneration, gas separation and liquefaction, heat economizing, and drying. Included are types providing as much as 300 to 350 sq ft of surface per cubic feet of volume. Modine Manufacturing.

Circle letter BK on reply card.

BL—COLD SEPARATION

The Parkersburg Rig and Reel Company has published a 52-page book on cold separation. It is a comprehensive and informative discussion on the application of Hyreco Processing Units, and is presented in question and answer form. The question and answer form provides an easily followed index, which enables the reader to find the answers to specific questions in a minimum of reading time. The book is expected to have wide acceptance among officials and field men alike. J. D. Lowd is author of the book. Parkersburg Rig and Reel Company.

Circle letter BL on reply card.

BM—CORROSION AID

A new bulletin, describing "Low Cost Corrosion Protection" has been published by Permolite, Inc. The 6-page folder explains Permolite pigmented organic corrosion resistant coatings, their application by brush, spray or dip . . . air-dried or baked. Pictures of various products and equipment protected with Permolite are shown, together with a list of typical applications. Illustrations and a description of the manufactuer's custom-coating plant are included. Permolite, Inc.

Circle letter BM on reply card.

BN—ENCLOSED MOTORS

A new bulletin released by Allis-Chalmers describes types of construction and ratings of its improved totally-enclosed, fan-cooled motors with tube-type, air-to-air heat exchangers. Included is a chart showing ratings of Allis-Chalmers fan-cooled motors available in squirrel-cage, wound-rotor, and synchronous types for both horizontal and vertical installation, and a cross section view of horizontal motor construction features. Among these are capsule-type bearings, protected air intakes, and pipe-plug protected, tapped holes for checking air gap with feeler gages. Allis-Chalmers.

Circle letter BN on reply card.

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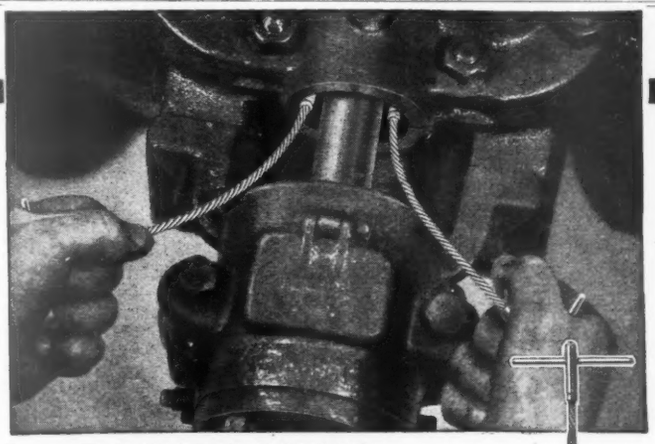

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BOOKS

Twenty-first Annual Resume of Rocky Mountain Oil and Gas Operations for 1950. *Published by Petroleum Information, Continental Oil Building, Denver, Colorado. Pages, 105. Price, $10.*

This 21st annual edition contains a complete review of exploratory oil activities throughout the 11 Rocky Mountain states. Beginning with a general resume, a brief review is given of the leasing activity, drilling and development of Western Nebraska, Colorado, Wyoming, Montana, Utah, Northern New Mexico, and South Dakota, including discovery well reports. Half the book is taken up with statistics of the individual states on geophysical activities, well completions, and the production of crude oil in the Rocky Mountain area.

Oil and Gas Production: An Introductory Guide to Production Techniques and Conservation Methods," *prepared by the Engineering Committee of the Interstate Oil Compact Commission. Pages, 140. Price, $2.75. State Capitol Building, Oklahoma City 5, Oklahoma.*

It is the purpose of this volume to explain clearly where oil and gas occur, the nature of the reservoirs in which they are found, and the technical sciences of utilizing and supplementing the natural forces available for their recovery. Included in the text are many illustrations, charts, graphs, and tables, which will simplify further the processes used to recover petroleum.

The book is sponsored by the Interstate Oil Compact Commission, an association of 20 oil and gas producing states. The volume has been prepared by its Enginering Committee to promote better oil and gas conservation.

Fundamental Research on Occurrence and Recovery of Petroleum, *by the Committee on Research, Board of Directors, of the American Petroleum Institute. Published by the API. Pages, 256. Price, $6.*

This volume is the fourth of a series that presents fundamental reesarch and reports of the directors of the several projects sponsored by the American Petroleum Institute in the field of occurrence and recovery of petroleum. Research projects 37, 27, 43, 47, and 49, are Fundamentals of Hydrocarbon Behavior, Function of Water in the Production of Oil From Reservoirs, The Role of Microorganisms in Petroleum Formation, Mechanism of the Development of Oil from Porous Materials, and Clay-Mineral Standards. Each one is covered in the papers presented in this book.

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Practical Oil Geology, *by Dorsey Hager, published by McGraw-Hill Book Company, New York. Pages, 556. Price, $7.50.*

Here is a book that shows how geology can aid in the finding and development of natural gas and petroleum. This new Sixth Edition contains several new sections on the findings of countless specialists on: Modern well-logging methods, a simpler classification of folding, and deep basin areas of the United States. Other major revisions of the book give a fuller treatment of subsurface mapping, oil property evaluation, and information for geologists who are called upon to give testimony in court. New tabular data have been added, among them Wentworth's classification for screen analysis of sediments, a table on producing horizons of West Texas and the Rocky Mountain area, etc.

Defense Without Inflation, *by Albert G. Hart, published by The Twentieth Century Fund, 330 West 42nd Street, New York 18, N. Y. Pages, 186. Price, $2.*

"Defense Without Inflation" is an analysis of the problem of preserving our civilian economy when paying for our large defense program. This volume is the first of a projected series, with an analysis of the main factors in the problem by Albert G. Hart, and recommendations by the Committee on Economic Stabilization. Chief needs recommended are: Pay-as-you go taxation, limitation of bank credit (accepting some rise in interest rate on government debt if necessary), and a truce on customary contests of bargaining power and pressure among the interest groups.

The Fischer-Tropsch and Related Synthesis, *by Henry H. Storch, Norma Golumbic, and Robert B. Anderson. Published by John Wiley and Sons, Inc., New York. Pages, 593. Price, $9.*

Data of high practical value to those engaged in research and development work related to fuels and chemical synthesis were made available in 1945 when combined teams of British and American chemists and engineers were given an opportunity to inspect German documents and interrogate German technologists.

The development of the Fischer-Tropsch process—the synthesis of aliphatic organic compounds, chiefly hydrocarbons and alcohols by the catalytic hydrogenation of carbon monoxide—is carefully reviewed.

ASTM Manual on Quality Control of Materials, *prepared by ASTM Committee E-11 on Quality Control of Materials. Pages, 163. Price, $1.*

Part 1 of the ASTM Manual is one of a series prepared by task groups of ASTM Technical Committee E-11 on Quality Control of Materials. This section discusses the application of statistical methods to the problem of (a) condensing the information contained in a single set of n observations, and presenting the essential information in concise form. Part 2 discusses $\neq$ limits of uncertainty of an average, and part 3 control chart method of analysis.

Stratigraphy and Sedimentation, *by W. C. Krumbein and L. L. Sloss, published by W. H. Freedman and Company, San Francisco, California. Pages, 448. Price, $5.*

Geologists in the petroleum industry will be interested in the manner in which the authors have integrated the subject matter of stratigraphy and sedimentation. It is the purpose of the book to assemble facts, principles, and hypotheses bearing upon stratigraphy and sedimentation in a form that may be studied in an efficient manner. An outgrowth of a combined course presented by the authors at Northwestern University, the volume lists certain basic concepts, a summary of modern methods of sediment description and classification, and an analysis of sedimentary processes, stratigraphic interpretation in terms of facies, correlation, tectonics, and paleogeography. The extensive bibliography of selected items covering the last 20 years is a notable item.